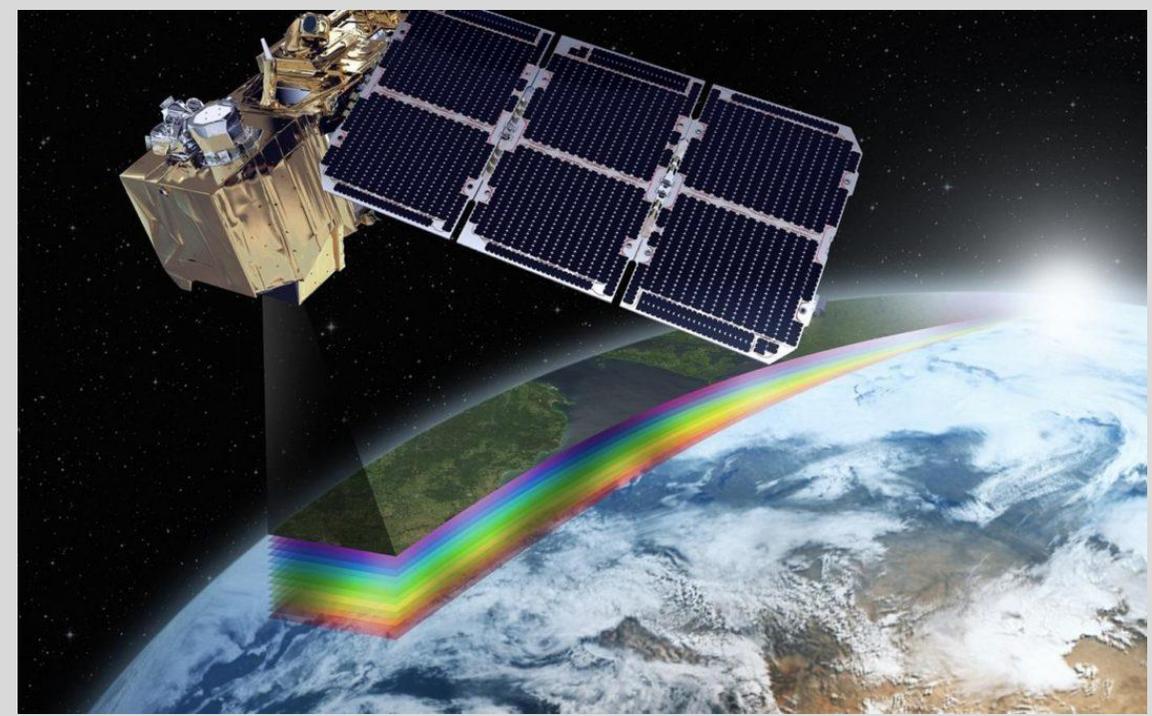


# Introduction to land change

FOR-247 : Methods and Tools in Tropical Forestry

The deforestation crisis has been acknowledged as a threat for decades

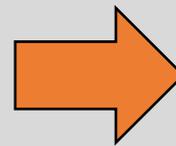


1987

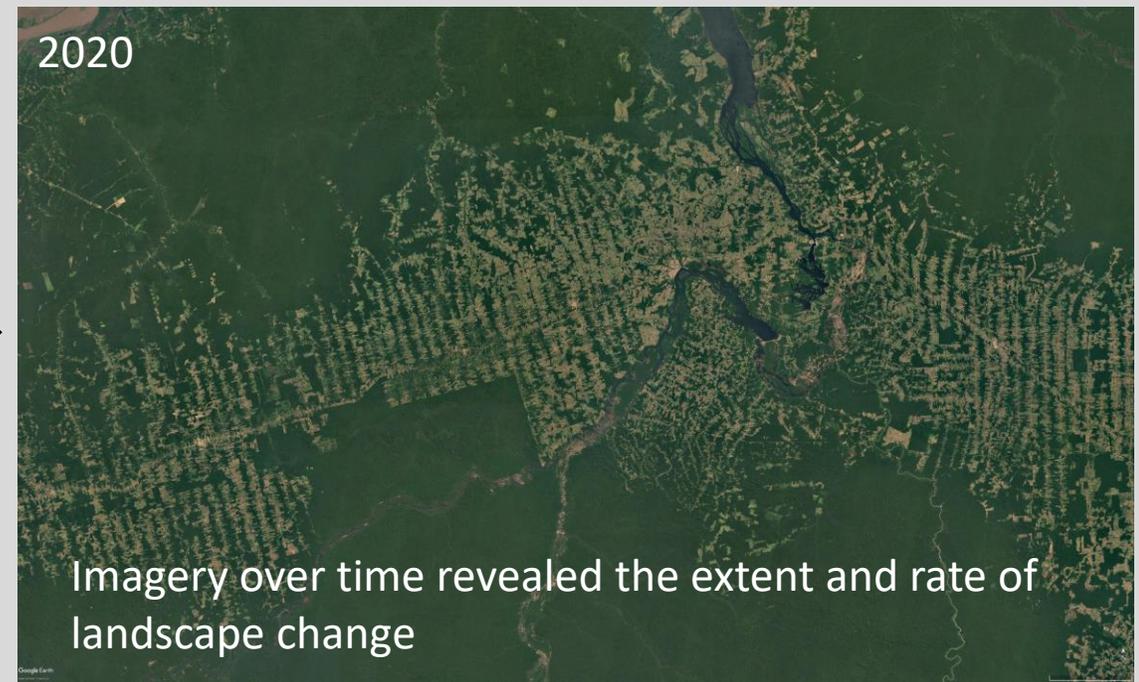
Northern Pará, Brazil



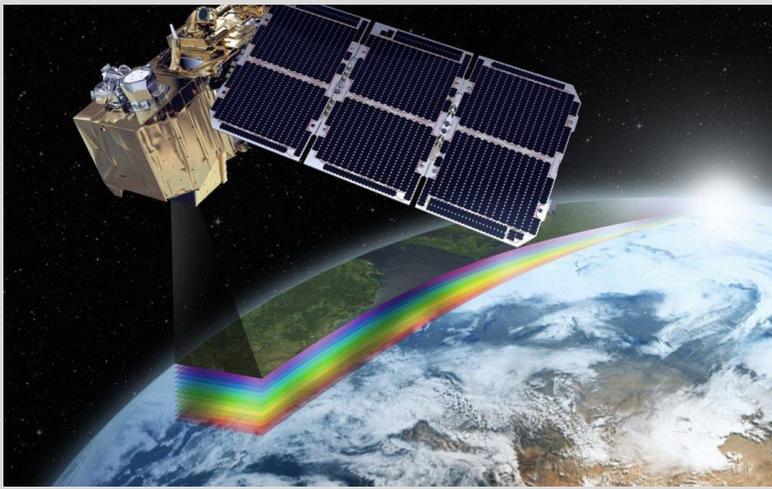
Imagery from space allowed humanity to get a novel perspective of land change and our impact



2020



Imagery over time revealed the extent and rate of landscape change

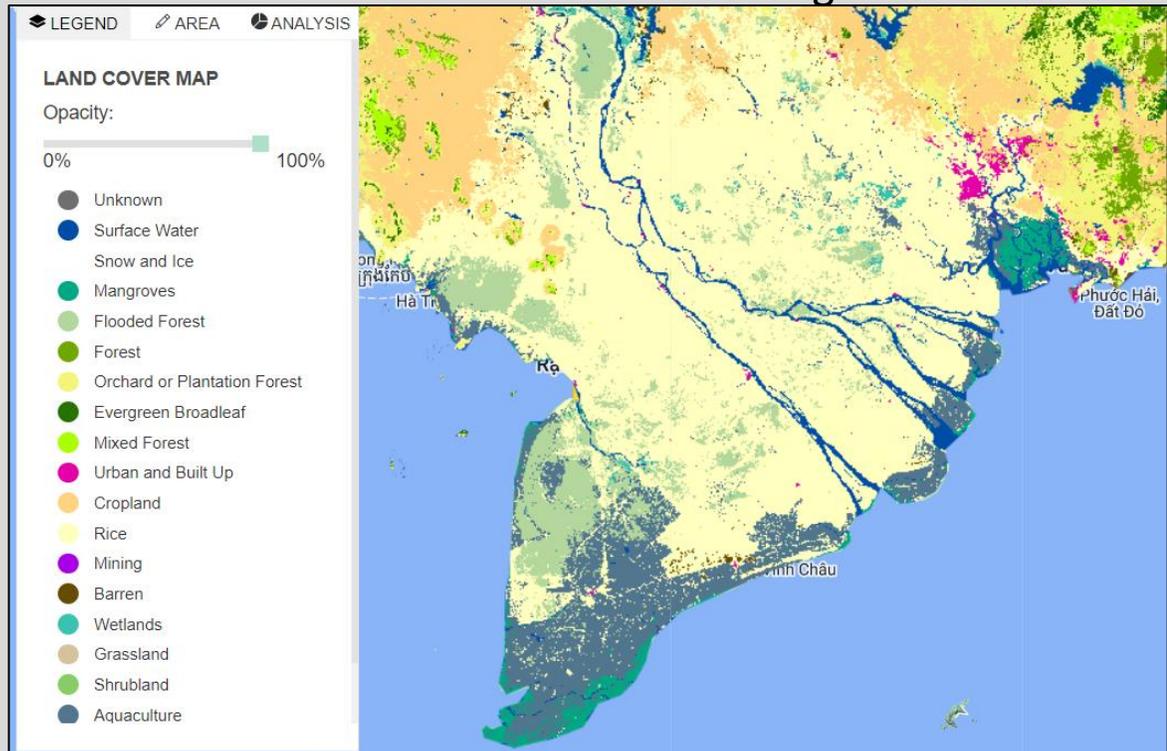


With improved sensors and increased computational power, satellite imagery could be used to create land cover maps through a process called **classification**.

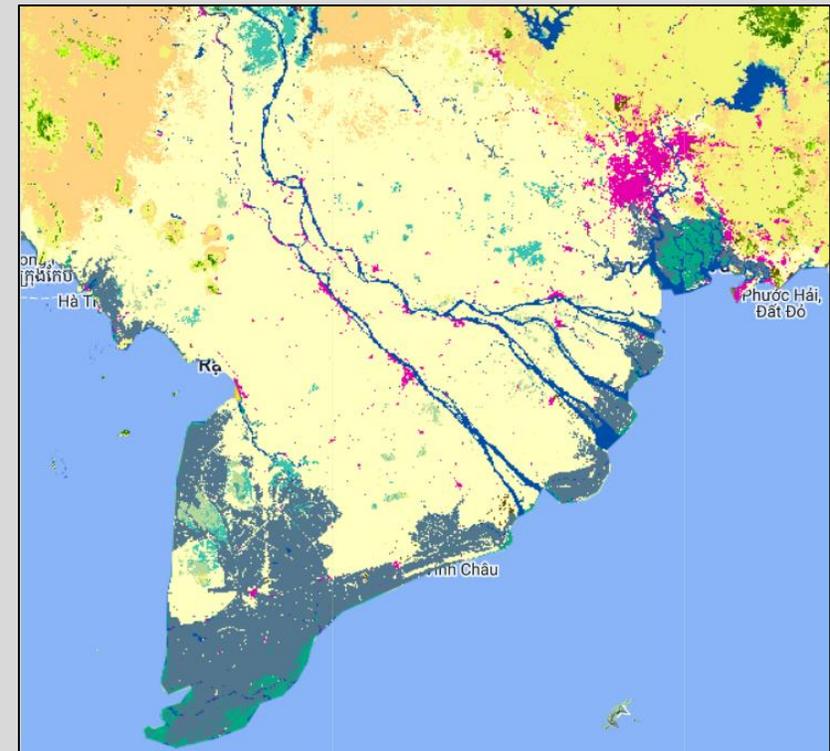
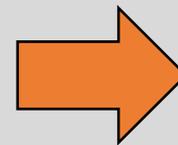
When land cover maps are created in sequence, the process of **land cover change** is revealed.

We can perform analyses to **quantify** different aspects of change.

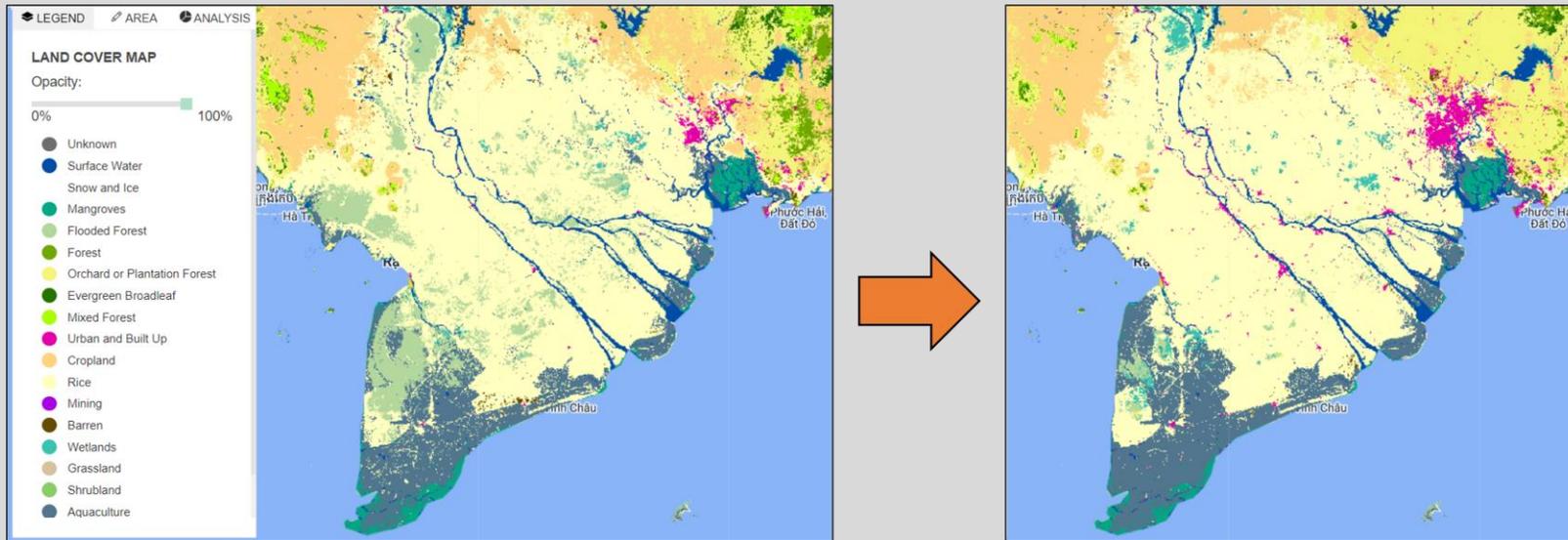
Mekong River delta 1987



2018



Land cover maps and their quantification over time (change analysis) establish spatiotemporal **patterns**.



**But, what are the causes of those changes?**

### Drivers of land change

#### Proximate causes

Aquaculture expansion  
Cropland expansion  
Logging  
Urbanization  
Reforestation  
Sea level rise



#### Underlying drivers

Trade policy  
Foreign investment  
Economics (inequity, opportunity)  
Migration  
Climate change



## Drivers of land change

### Proximate causes

- Aquaculture expansion
- Cropland expansion
- Logging
- Urbanization
- Reforestation
- Sea level rise



### Underlying drivers

- Trade policy
- Foreign investment
- Economics (inequity, opportunity)
- Migration
- Climate change

## Objectives of the next three sessions:

Become familiar with geospatial data

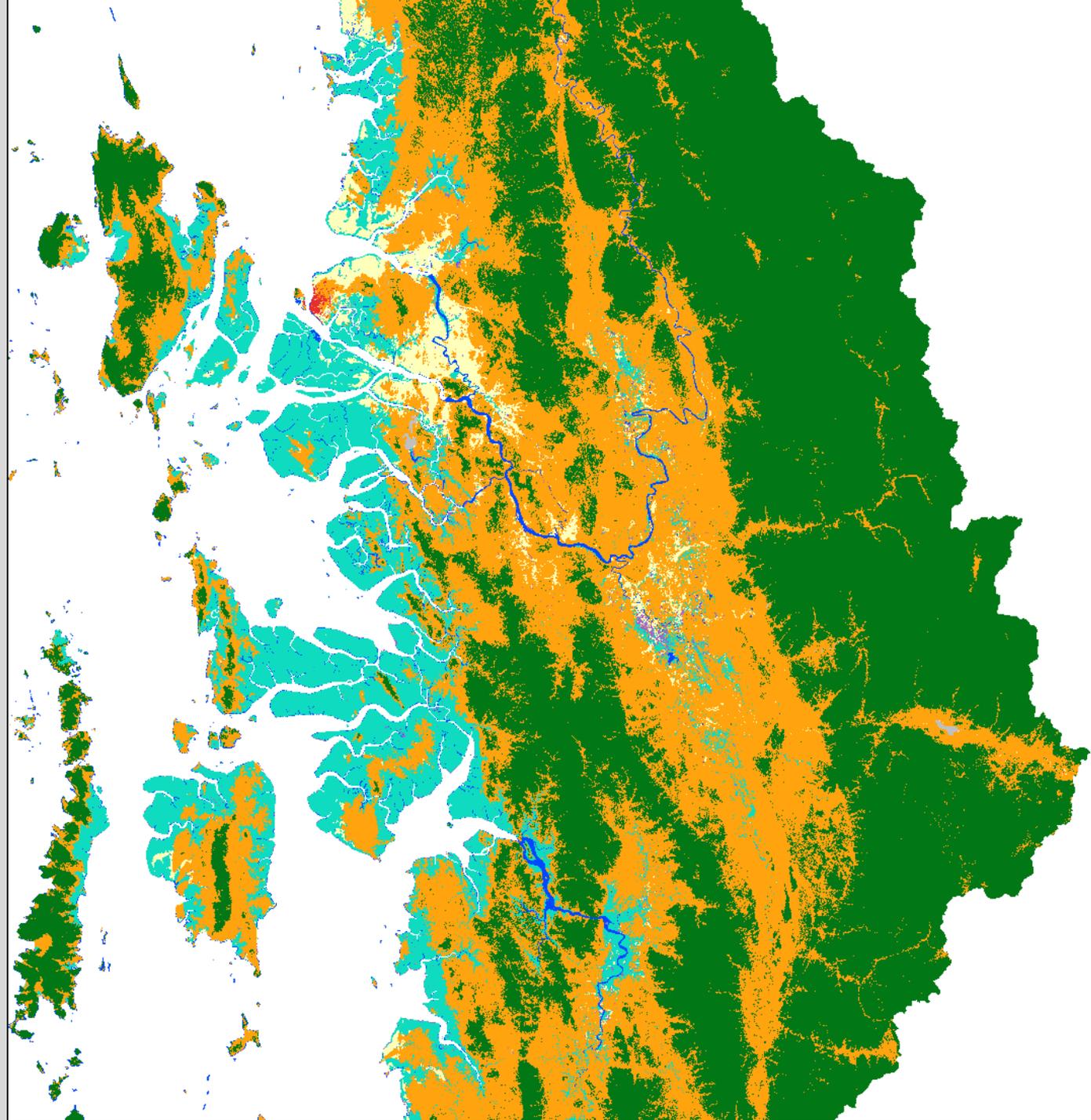
Visualize land cover maps in a GIS

Quantify land cover change over time

Present and interpret land cover change

Future sessions will introduce you to some of the field techniques used to collect information on the dynamics and drivers of land change, along with the impacts of change on livelihoods.

Slides prepared by  
Johanness Jamaludin

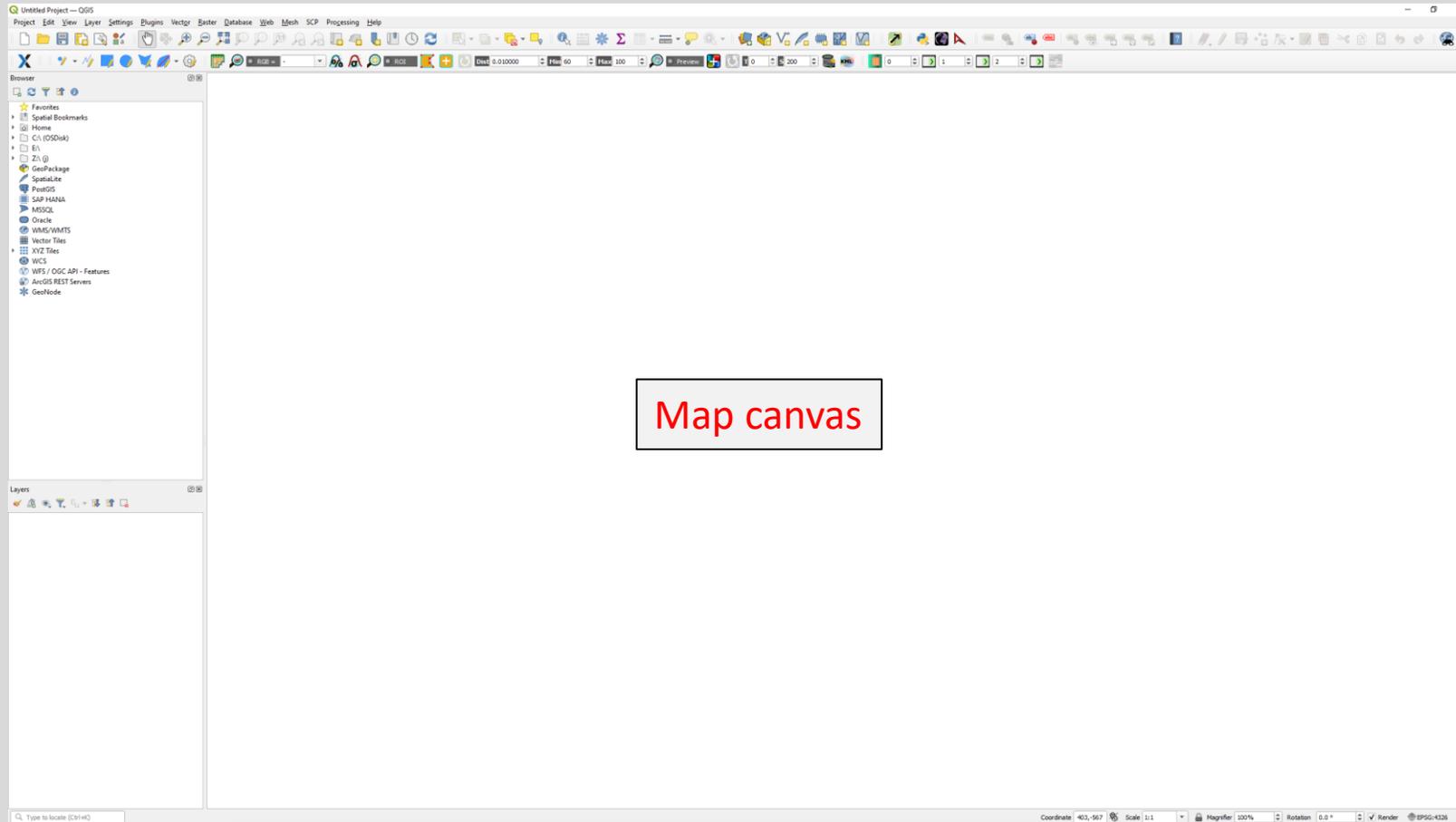




Slides prepared by  
Johanness Jamaludin

# QGIS Graphical User Interface

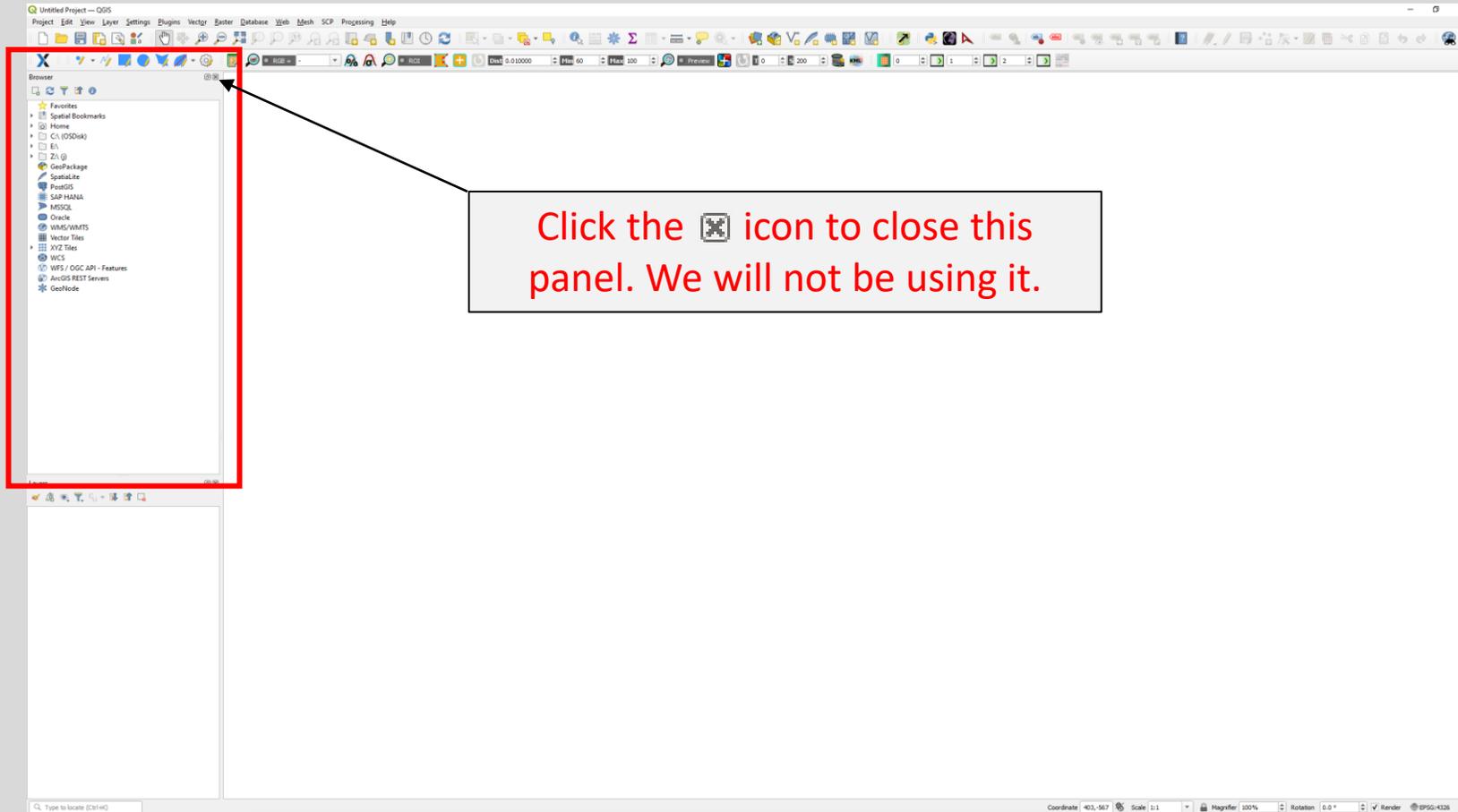
# QGIS basics



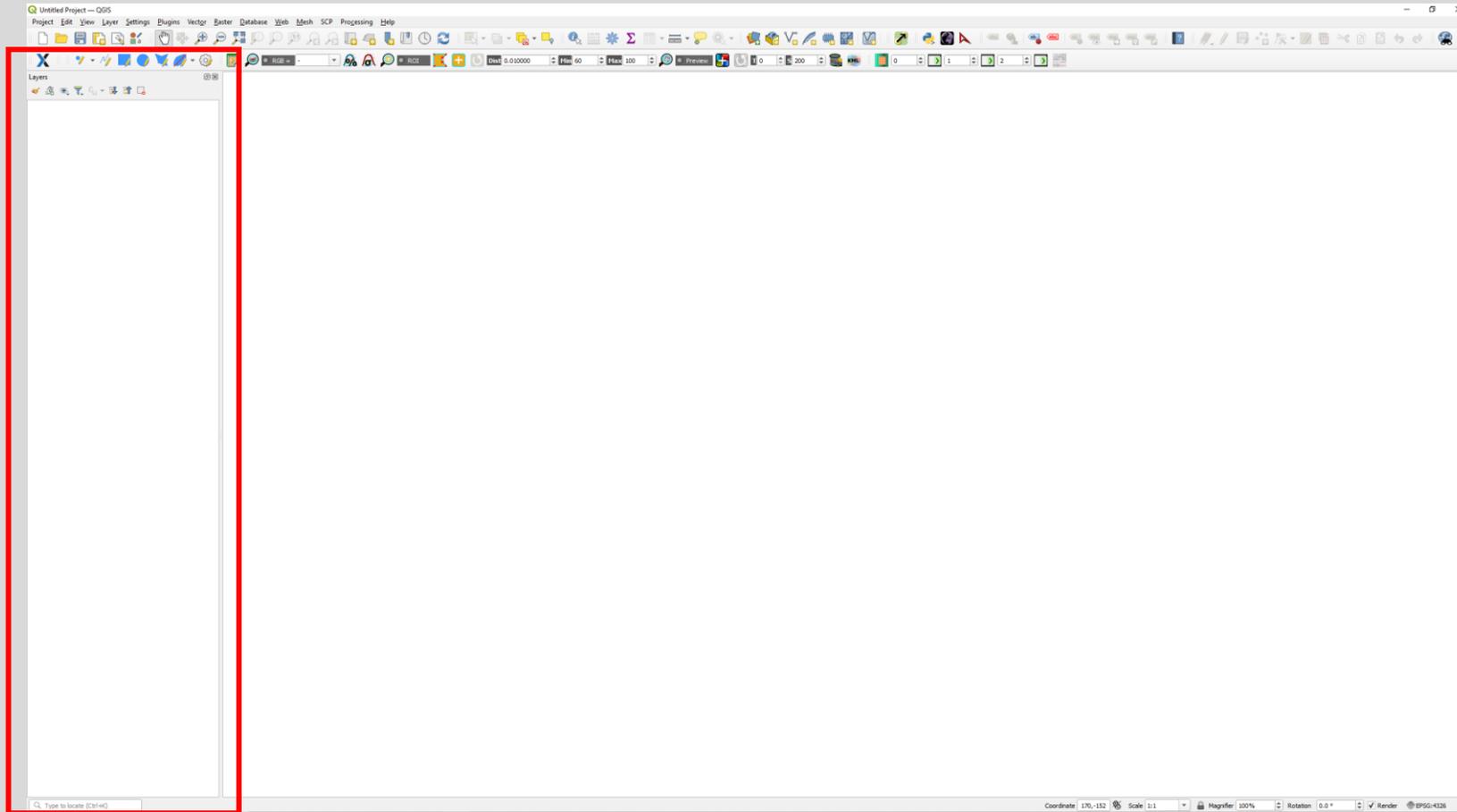
# QGIS Graphic User Interface

Browser panel

Click the  icon to close this panel. We will not be using it.

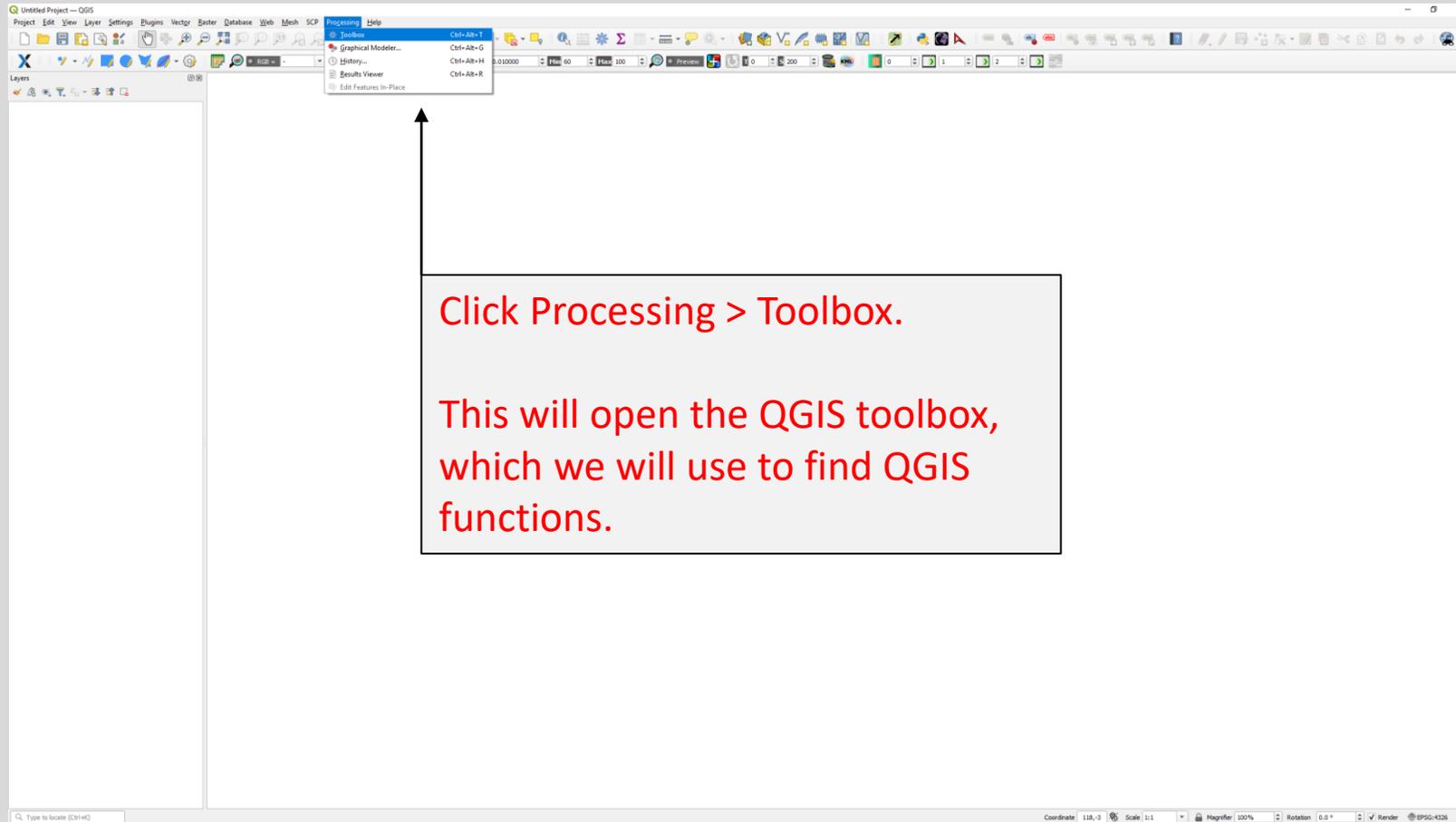


# QGIS basics

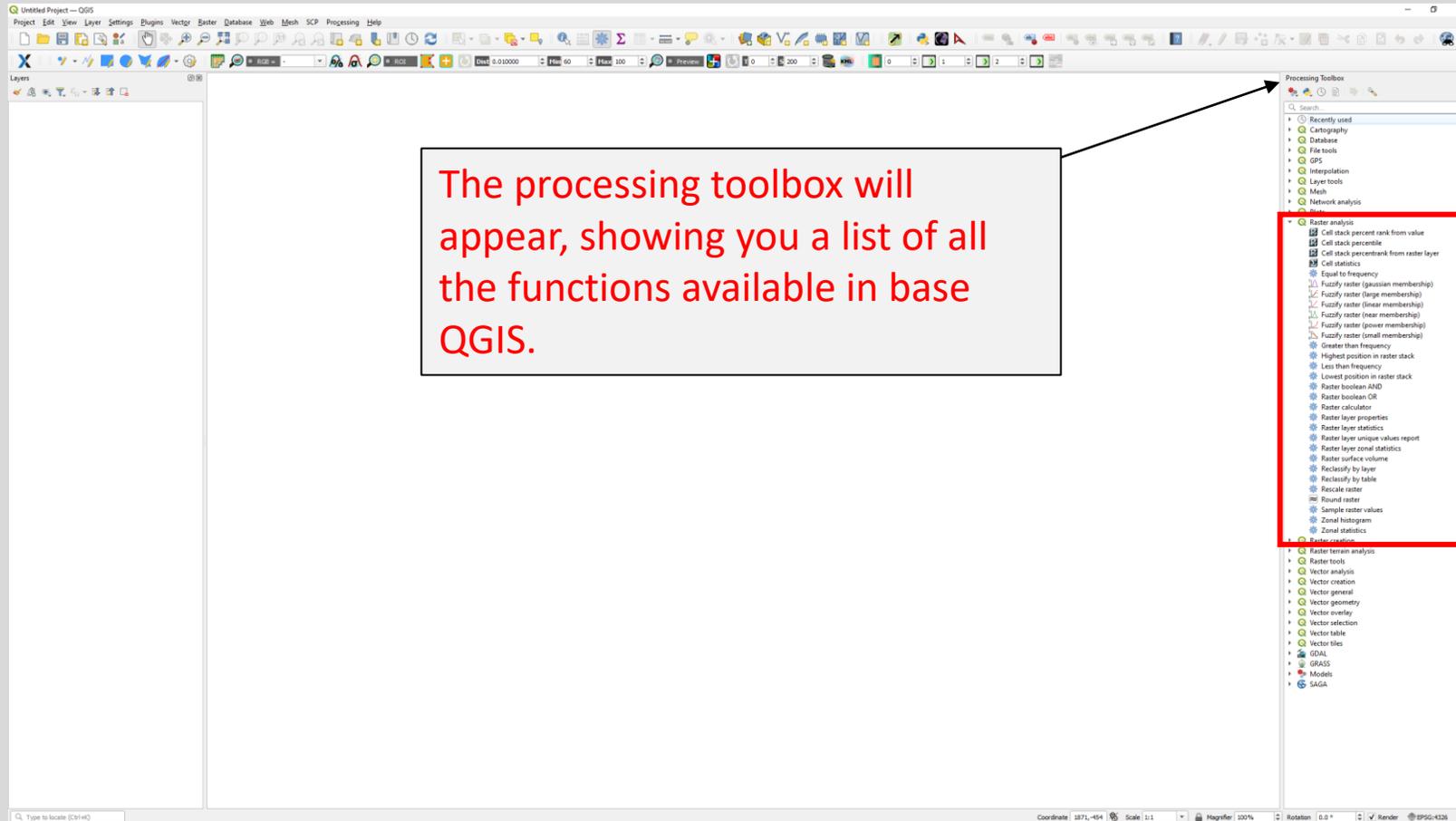


Layers panel

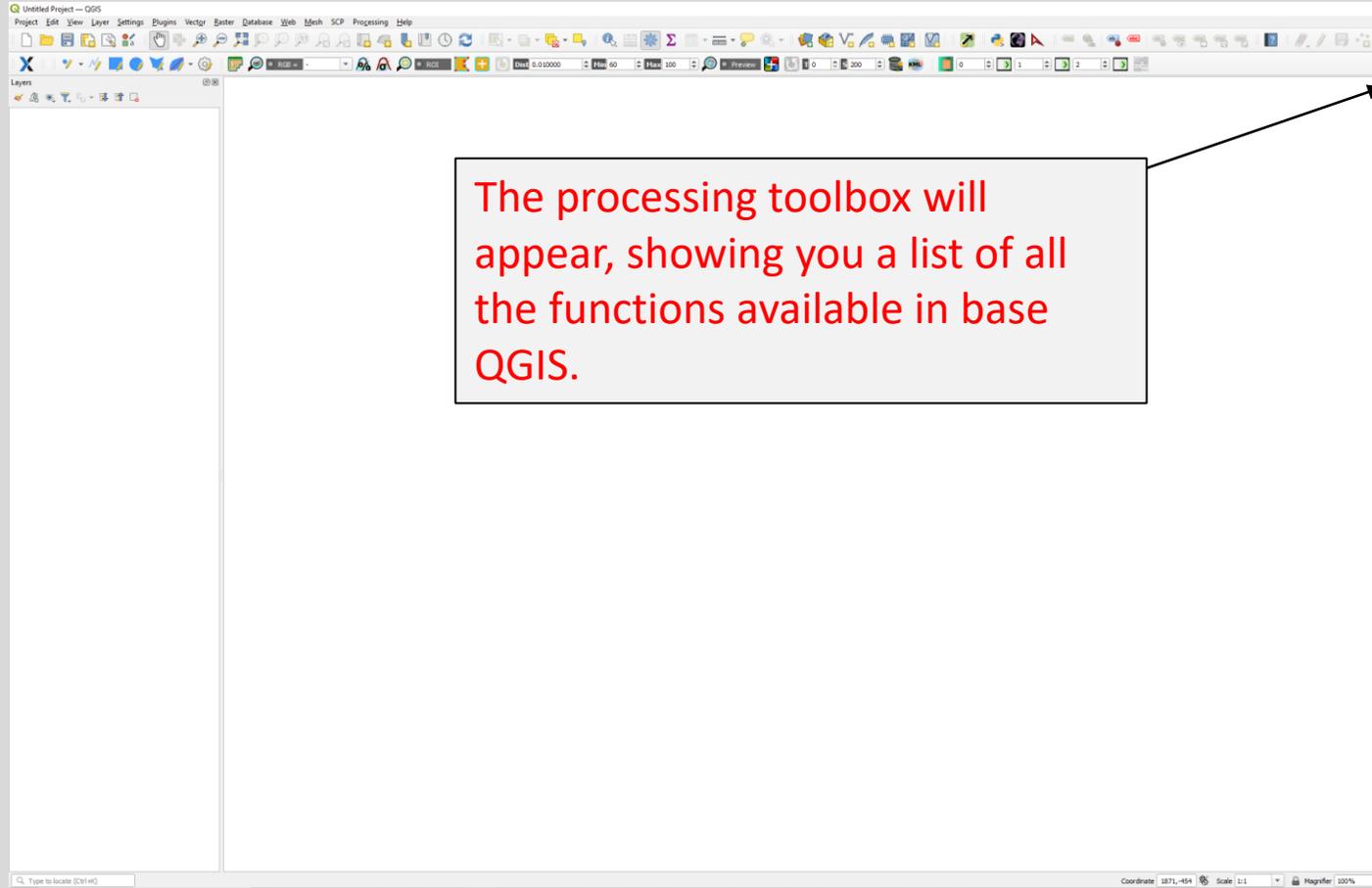
# QGIS basics



# QGIS basics



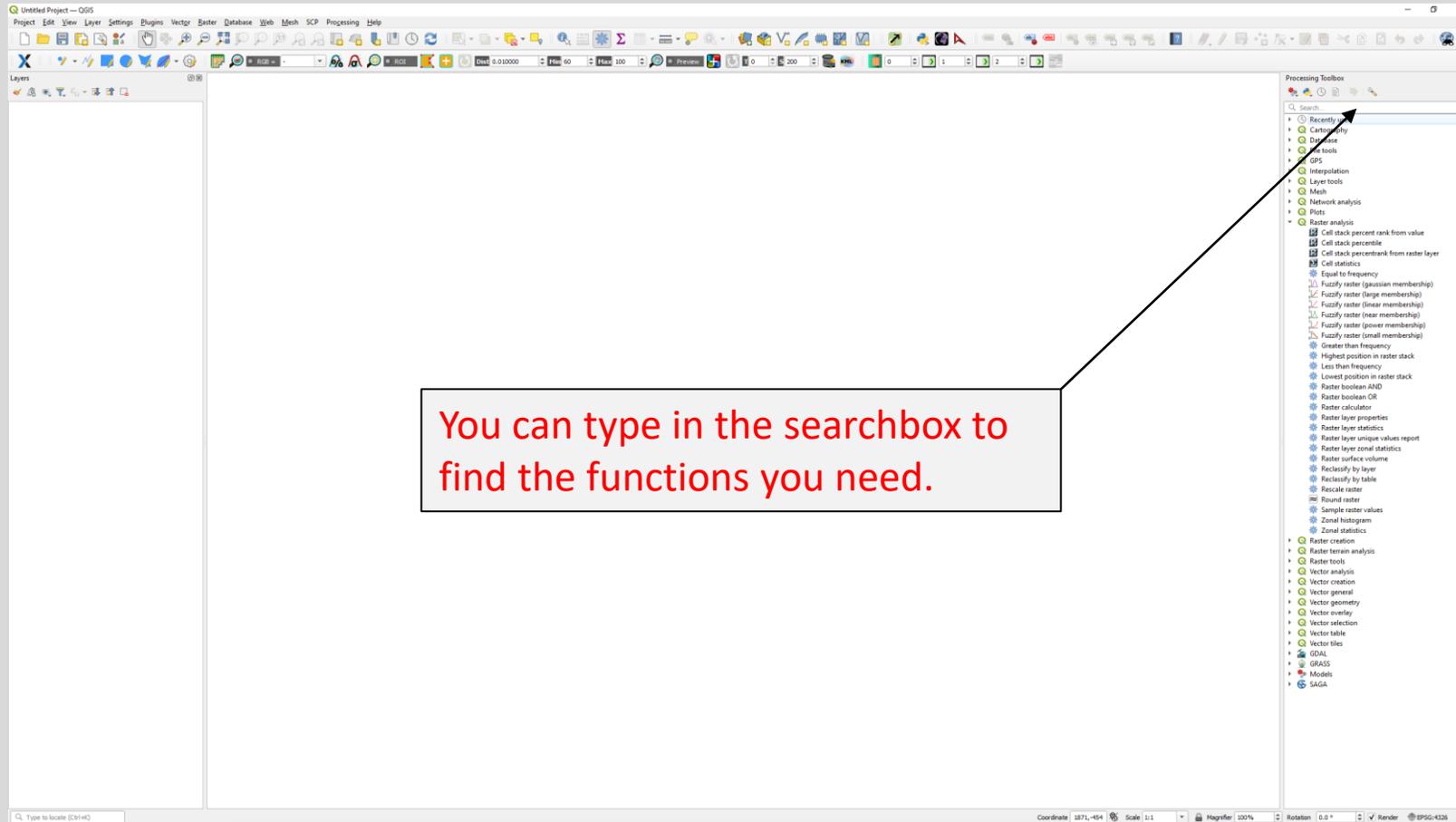
# QGIS basics



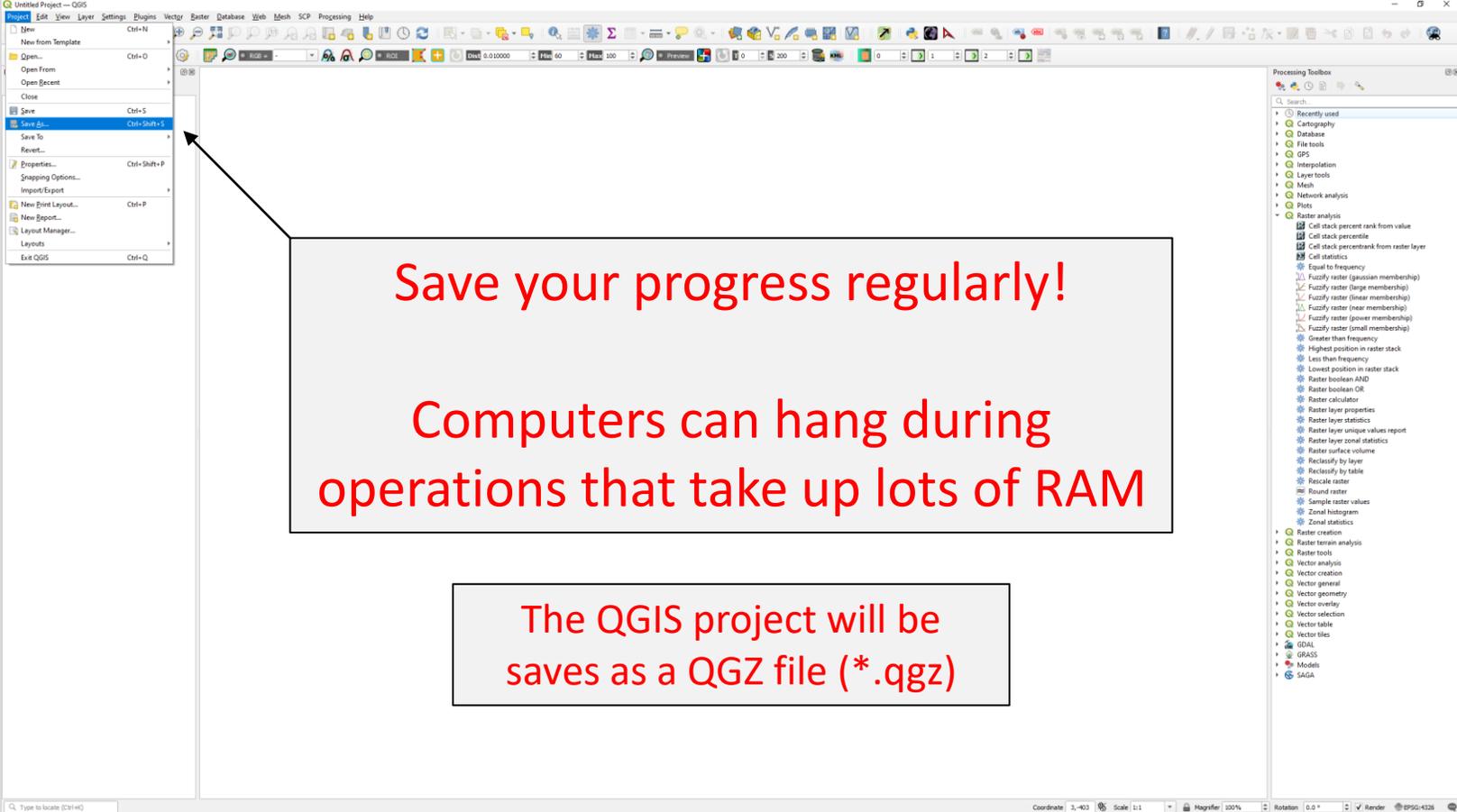
The processing toolbox will appear, showing you a list of all the functions available in base QGIS.

- Q Raster analysis
  - Cell stack percent rank from value
  - Cell stack percentile
  - Cell stack percentrank from raster layer
  - Cell statistics
  - Equal to frequency
  - Fuzzify raster (gaussian membership)
  - Fuzzify raster (large membership)
  - Fuzzify raster (linear membership)
  - Fuzzify raster (near membership)
  - Fuzzify raster (power membership)
  - Fuzzify raster (small membership)
  - Greater than frequency
  - Highest position in raster stack
  - Less than frequency
  - Lowest position in raster stack
  - Raster boolean AND
  - Raster boolean OR
  - Raster calculator
  - Raster layer properties
  - Raster layer statistics
  - Raster layer unique values report
  - Raster layer zonal statistics
  - Raster surface volume
  - Reclassify by layer
  - Reclassify by table
  - Rescale raster
  - Round raster
  - Sample raster values
  - Zonal histogram
  - Zonal statistics
- Q Raster creation

# QGIS basics



# QGIS basics



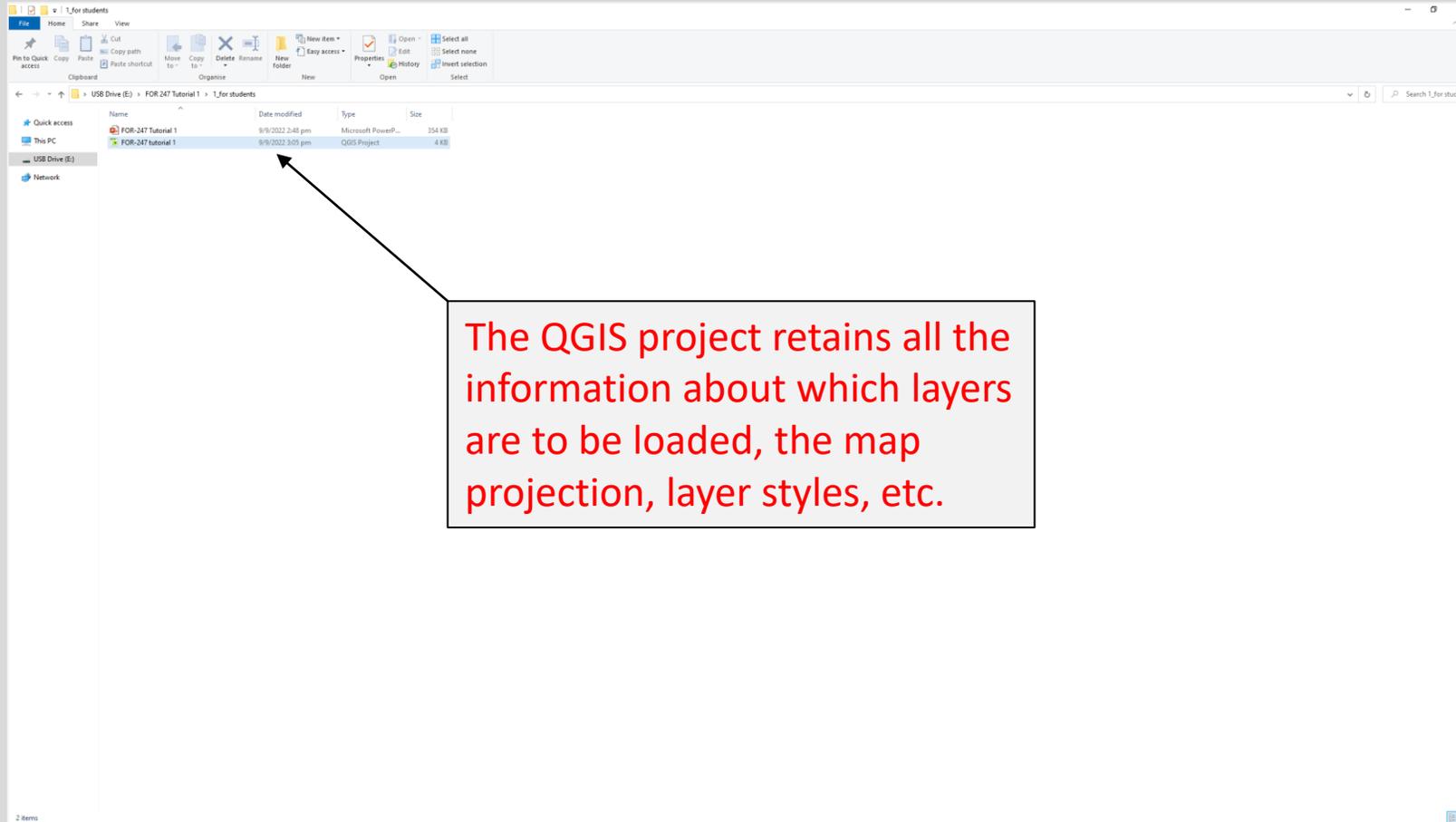
The image shows a screenshot of the QGIS desktop application. The 'Project' menu is open, and the 'Save As...' option is highlighted. A black arrow points from this option to a large white callout box with a black border. Inside this box, the text 'Save your progress regularly!' is written in red at the top, followed by 'Computers can hang during operations that take up lots of RAM' in red. Below this, a smaller white callout box with a black border contains the text 'The QGIS project will be saves as a QGZ file (\*.qgz)' in red. The background shows the QGIS interface with various toolbars and panels, including the Processing Toolbox on the right.

**Save your progress regularly!**

**Computers can hang during operations that take up lots of RAM**

**The QGIS project will be saves as a QGZ file (\*.qgz)**

# QGIS basics



Land cover data

# SERVIR Mekong RLCMS



[Home](#) [Services](#) [Dashboard](#) [Methodology](#) [Library](#) [About](#)

## Regional Land Cover Monitoring System

"Space to Village: monitoring land cover and land use change in the Lower Mekong"

[Read More](#)

## Land Cover

"High quality regional land cover mapping at 30-m resolution using satellite technology"

[Our Services](#)

## Forest Monitoring

"Empowering decision-makers with frequently updated maps, leveraging the advantages of open-source remote sensing data"

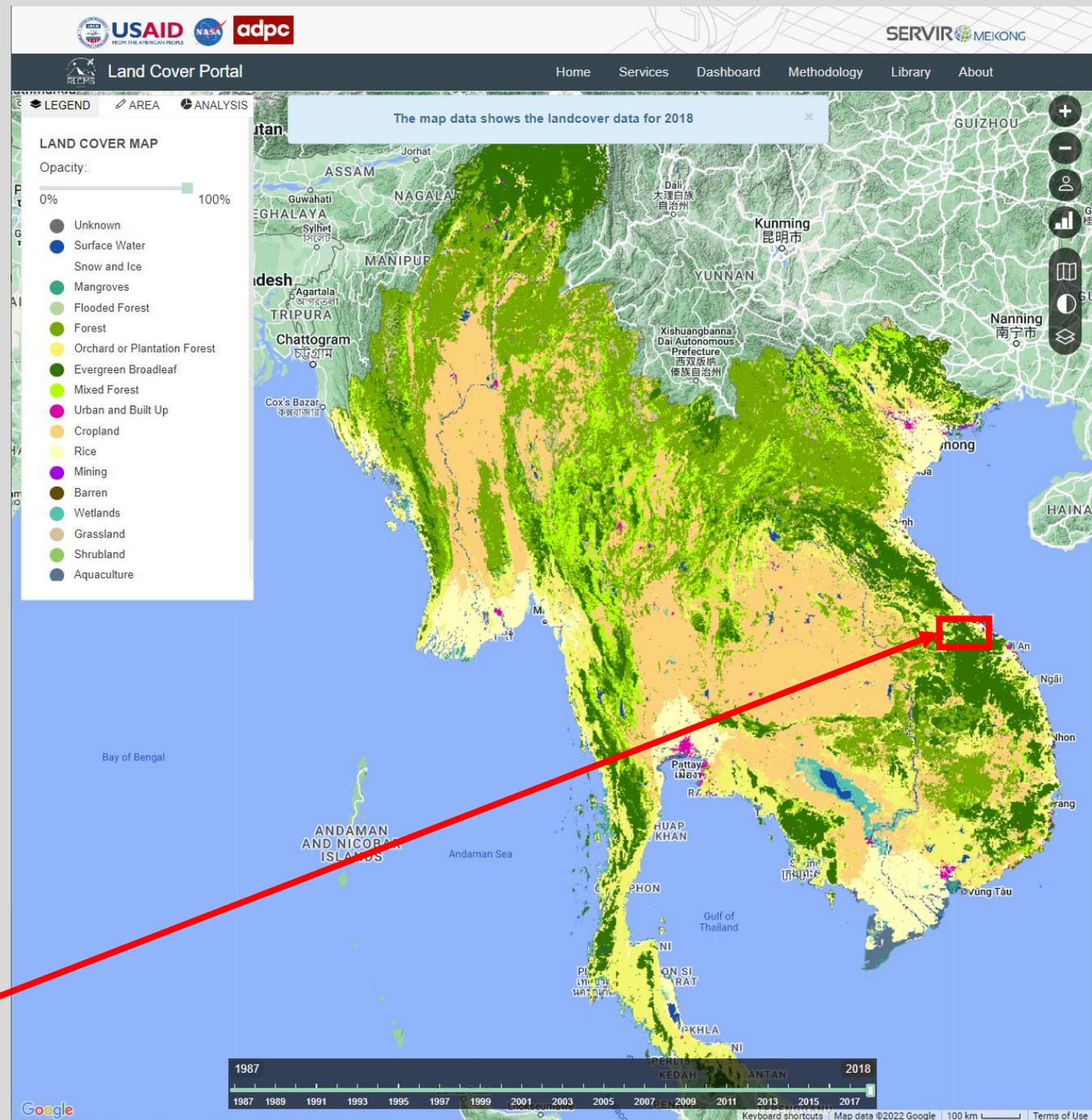
[Our Services](#)

# General information

- Annual land cover from 1987–2018
- 30 m spatial resolution
- 17 land cover categories
- The data can be viewed and accessed from this link:

<https://www.landcovermapping.org/en/landcover/>

[Exploration of data using Hue, Vietnam as an example]

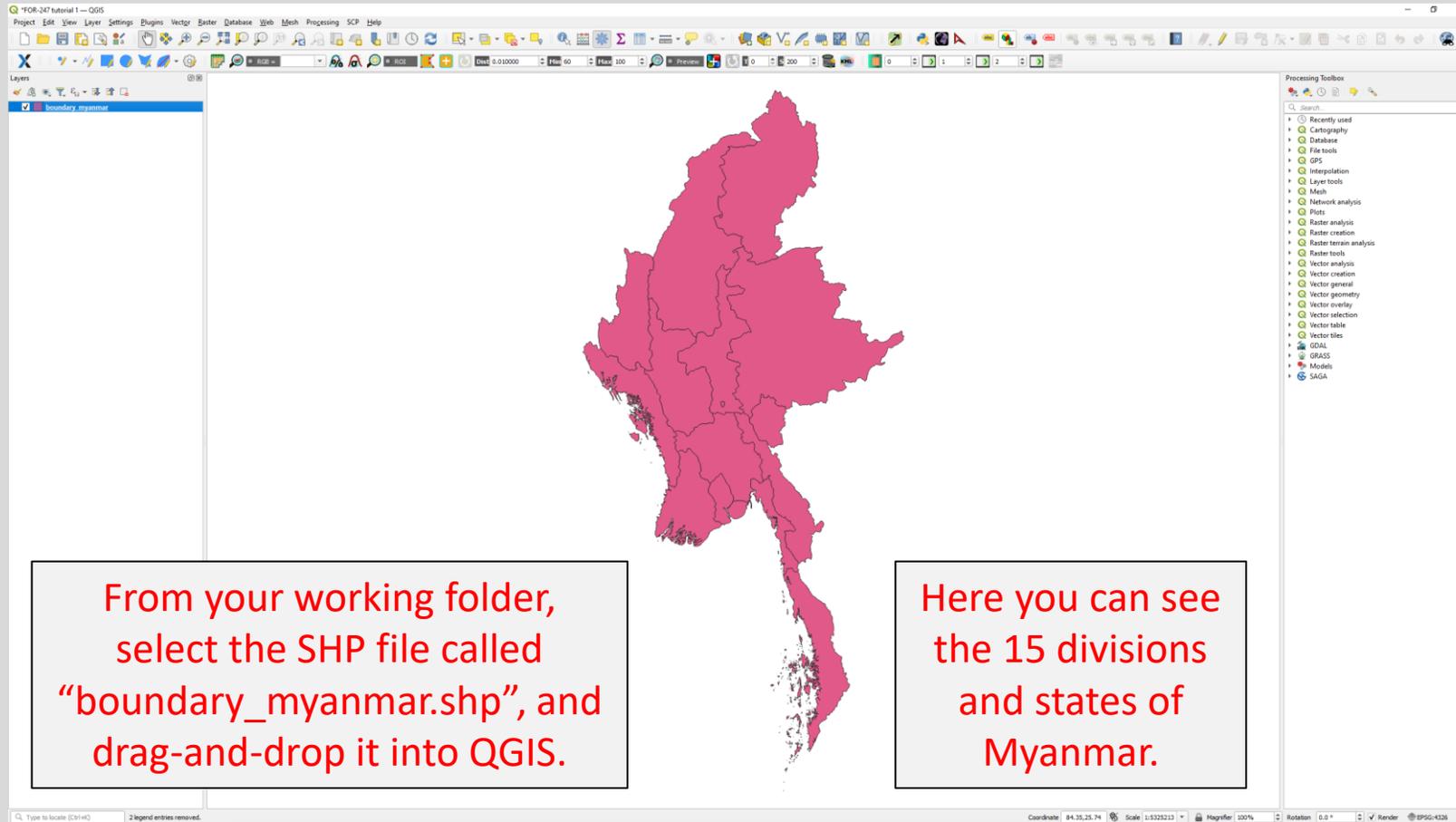


# Land cover example: Tanintharyi, Myanmar

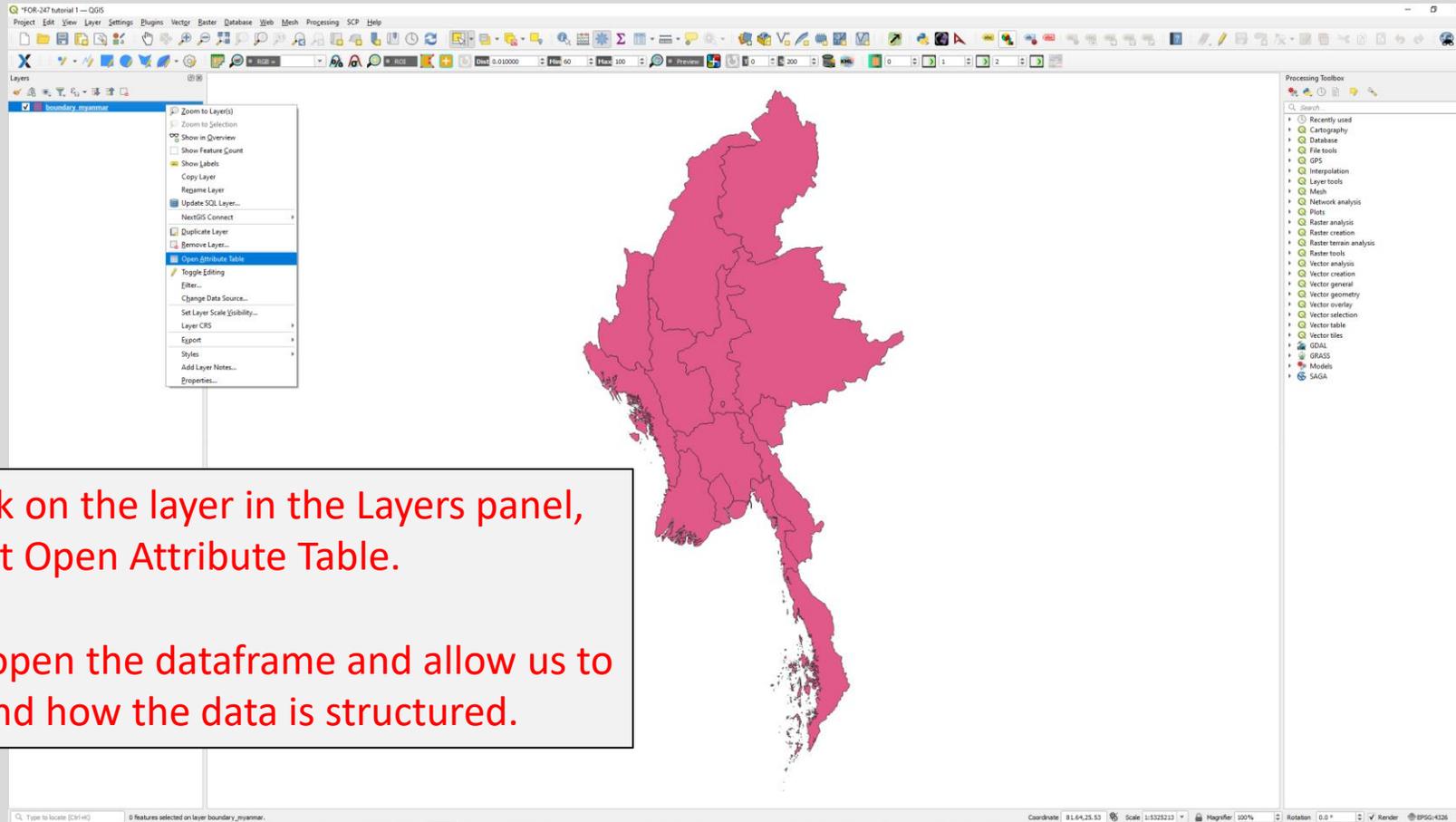
- You should have downloaded the data from the Moodle page
- The data are:
  1. SERVIR Mekong land cover data for 1987 and 2018
  2. Data on the subnational administrative boundaries of Myanmar (i.e., state, district etc.)

Vector data processing

# Load the admin boundary data for Myanmar



# Vector attribute table



# Vector attribute table

Each column contains different information on the naming and categorization of each region.

There are 15 rows in this table. Each row corresponds to one of the 15 administrative regions.

GID_1	GID_0	COUNTRY	NAME_1	VARNAME_1	NL_NAME_1	TYPE_1	ENGTYP_1	CC_1	HASC_1	ISO_1
1	MMR_1_1	Myanmar	Ayeyawady	IrrawaddyJey...	NA	Yin	Division	NA	MMAY	MM-07
2	MMR_2_1	Myanmar	Bago	PegouPegu	NA	Yin	Division	NA	MMBA	MM-02
3	MMR_3_1	Myanmar	Chin	Chin Hills	NA	Pyine	State	NA	MMCH	NA
4	MMR_4_1	Myanmar	Kachin	Jingshaw Mun...	NA	Pyine	State	NA	MMKC	MM-11
5	MMR_5_1	Myanmar	Kayah	Kareni	NA	Pyine	State	NA	MMKH	MM-12
6	MMR_6_1	Myanmar	Kayah	KawthulejKare...	NA	Pyine	State	NA	MMKN	MM-13
7	MMR_7_1	Myanmar	Magway	MagweMimbu	NA	Yin	Division	NA	MMMG	MM-03
8	MMR_8_1	Myanmar	Mandalay	NA	NA	Yin	Division	NA	MMMD	MM-04
9	MMR_9_1	Myanmar	Mon	Mun	NA	Pyine	State	NA	MMMO	MM-15
10	MMR_10_1	Myanmar	Naypyitaw	NaypyidawNay...	NA	Union territory	Union territory	NA	MMNV	NA
11	MMR_11_1	Myanmar	Rakhine	Arakan	NA	Pyine	State	NA	MMRA	MM-16
12	MMR_12_1	Myanmar	Sagaing	NA	NA	Yin	Division	NA	MMSA	MM-01
13	MMR_13_1	Myanmar	Shan	NA	NA	Pyine	State	NA	MMSH	MM-17
14	MMR_14_1	Myanmar	Tinintharyi	Tenasserim[Tha...	NA	Yin	Division	NA	MMTN	MM-05
15	MMR_15_1	Myanmar	Yangon	RangoonRang...	NA	Yin	Division	NA	MMYA	MM-06

An attribute table is equivalent to an Excel sheet

# Vector attribute table

The screenshot displays the QGIS interface with a map of Myanmar. A vector attribute table window is open, showing the following data:

ID	GID_1	GID_0	COUNTRY	NAME_1	VARNAME_1	NR
1	MMR_1_1	MMR	Myanmar	Ayeyawady	Irawaddy(Ayey...	NA
2	MMR_2_1	MMR	Myanmar	Bago	Pegou(Pegu)	NA
3	MMR_3_1	MMR	Myanmar	Chin	Chin Hills	NA
4	MMR_4_1	MMR	Myanmar	Kachin	Jingphaw Mun...	NA
5	MMR_5_1	MMR	Myanmar	Kayah	Karenni	NA
6	MMR_6_1	MMR	Myanmar	Kayin	Kawthule(Kare...	NA
7	MMR_7_1	MMR	Myanmar	Magway	Magway(Mebu)	NA
8	MMR_8_1	MMR	Myanmar	Mandalay	NA	NA
9	MMR_9_1	MMR	Myanmar	Mon	Mun	NA
10	MMR_10_1	MMR	Myanmar	Naypyitaw	Naypyidaw(Nay...	NA
11	MMR_11_1	MMR	Myanmar	Rakhine	Arakan	NA
12	MMR_12_1	MMR	Myanmar	Sagaing	NA	NA
13	MMR_13_1	MMR	Myanmar	Shan	NA	NA
14	MMR_14_1	MMR	Myanmar	Tanintharyi	Tanasserim(Tha...	NA
15	MMR_15_1	MMR	Myanmar	Yangon	Rangoon(Rang...	NA

A red box with the text "Resize and move table here" is positioned below the table window.

# Vector attribute table

Select any region by clicking on the row

Ayeyarwady region

ID	COUNTRY	NAME	URNAME
1	Myanmar	Ayeyarwady	Ayeyarwady
2	Myanmar	Bago	Pegon/Pegu
3	Myanmar	Chin	Chin Hills
4	Myanmar	Kachin	Jinghaw Mun...
5	Myanmar	Kayah	Karenni
6	Myanmar	Kayin	Kawthule/Kare...
7	Myanmar	Magway	Magway/Mebu
8	Myanmar	Mandalay	NA
9	Myanmar	Mon	Mun
10	Myanmar	Naypyitaw	Naypyidaw/Nay...
11	Myanmar	Rakhine	Arakan
12	Myanmar	Sagaing	NA
13	Myanmar	Shan	NA
14	Myanmar	Tanintharyi	Tanasserim(Tha...
15	Myanmar	Yangon	Rangoon/Rang...

# Vector attribute table

The screenshot displays the QGIS interface with a map of Myanmar. A vector attribute table window is open, showing the following data:

ID	GID_1	GID_0	COUNTRY	NAME_1	UPPERNAME_1	NA
1	MMR_1_1	MMR	Myanmar	Ayeyarwady	Irawaddy(Ayey...	NA
2	MMR_2_1	MMR	Myanmar	Bago	Pégou(Pegu)	NA
3	MMR_3_1	MMR	Myanmar	Chin	Chin Hills	NA
4	MMR_4_1	MMR	Myanmar	Kachin	Jingphaw Mun...	NA
5	MMR_5_1	MMR	Myanmar	Kayah	Karenni	NA
6	MMR_6_1	MMR	Myanmar	Kayin	Kawthule(Kare...	NA
7	MMR_7_1	MMR	Myanmar	Magway	Magwe(Mebu)	NA
8	MMR_8_1	MMR	Myanmar	Mandalay	NA	NA
9	MMR_9_1	MMR	Myanmar	Mon	Mun	NA
10	MMR_10_1	MMR	Myanmar	Naypyitaw	Naypyidaw(Nay...	NA
11	MMR_11_1	MMR	Myanmar	Rakhine	Arakan	NA
12	MMR_12_1	MMR	Myanmar	Sagaing	NA	NA
13	MMR_13_1	MMR	Myanmar	Shan	NA	NA
14	MMR_14_1	MMR	Myanmar	Tanintharyi	Tanintharyi(Ta...	NA
15	MMR_15_1	MMR	Myanmar	Yangon	Rangoon(Rang...	NA

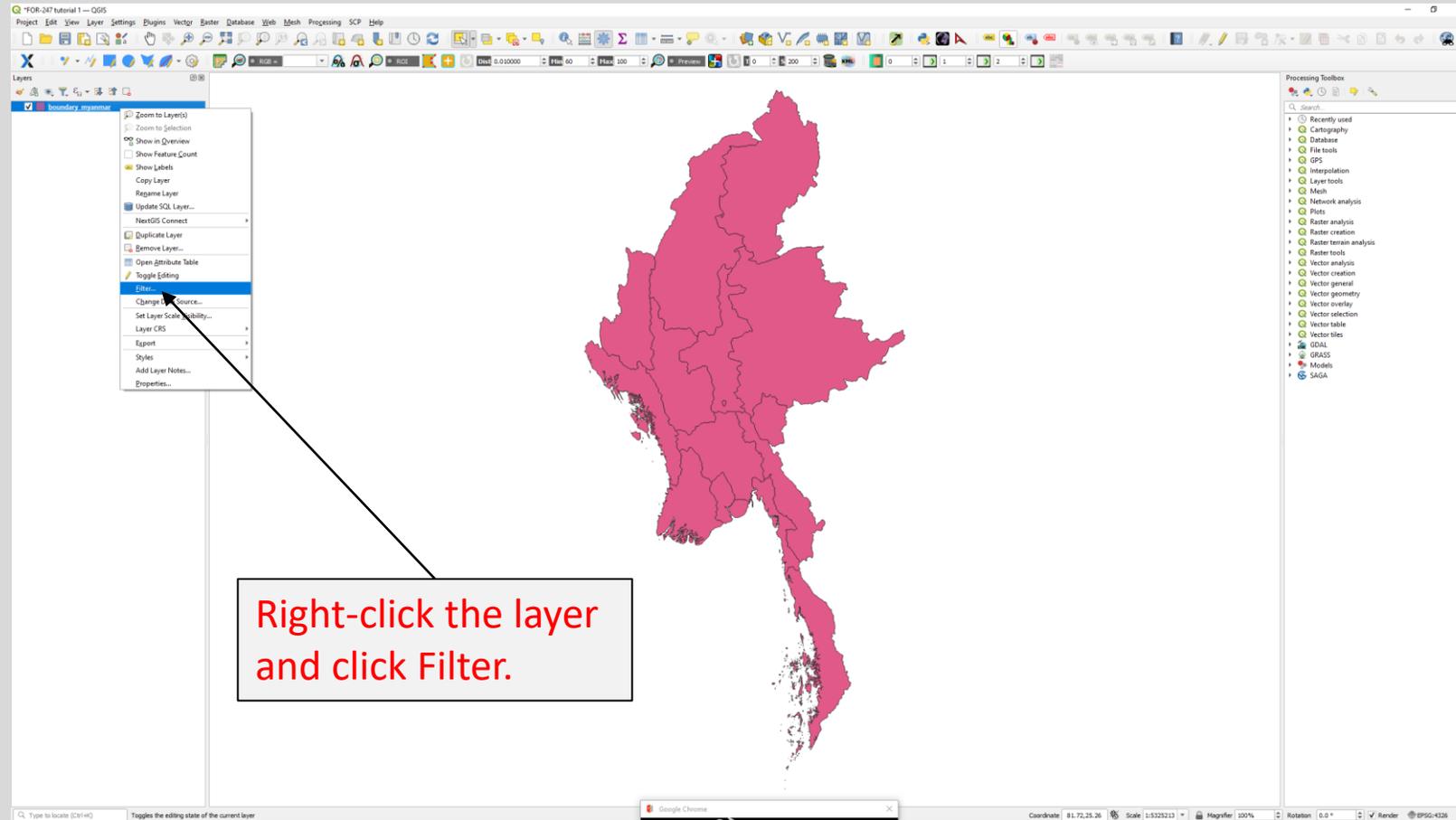
A red text box with a black border is overlaid on the map, containing the text: "We will focus on Tanintharyi".

# Vector attribute table

Deselect all features by clicking this button  .

GID_1	GID_0	COUNTRY			
1	MMR_1_1	Myanmar	Ayeyarwady	Irrawaddy(Ayey...	NA
2	MMR_2_1	Myanmar	Bago	Pegou/Pegu	NA
3	MMR_3_1	Myanmar	Chin	Chin Hills	NA
4	MMR_4_1	Myanmar	Kachin	Jingshaw Mun...	NA
5	MMR_5_1	Myanmar	Kayah	Karenzi	NA
6	MMR_6_1	Myanmar	Kayin	Kaithule(Kars...	NA
7	MMR_7_1	Myanmar	Magway	Magwe/Mebu	NA
8	MMR_8_1	Myanmar	Mandalay	NA	NA
9	MMR_9_1	Myanmar	Mon	Mun	NA
10	MMR_10_1	Myanmar	Naypyitaw	Naypyidaw(Nay...	NA
11	MMR_11_1	Myanmar	Rakhine	Arakan	NA
12	MMR_12_1	Myanmar	Sagaing	NA	NA
13	MMR_13_1	Myanmar	Shan	NA	NA
14	MMR_14_1	Myanmar	Tanintharyi	Tanasserim(Tha...	NA
15	MMR_15_1	Myanmar	Yangon	Rangoon(Rang...	NA

# Filtering the Shapefile to Tanintharyi



# Filtering the Shapefile to Tanintharyi

Double-click the "NAME\_1" field. A field represents a column in the attribute table.

"NAME\_1" will be entered into the expression box.

The screenshot shows the QGIS interface with the 'Query Builder' dialog box open. The 'Fields' list contains the following fields: `GID_1`, `GID_0`, `COUNTRY`, `NAME_1` (highlighted), `VARNAME_1`, `NL_NAME_1`, `TYPE_1`, `ENDTYPE_1`, `CC_1`, `HASC_1`, and `ISO_1`. The 'Provider Specific Filter Expression' box contains the text `"NAME_1"`. The 'Operators' section shows various logical operators like `=`, `<`, `>`, `LIKE`, `%`, `IN`, `NOT IN`, `<=`, `>=`, `!=`, `BETWEEN`, `AND`, `OR`, and `NOT`. The 'Processing Toolbox' on the right side of the interface lists various GIS tools and plugins.

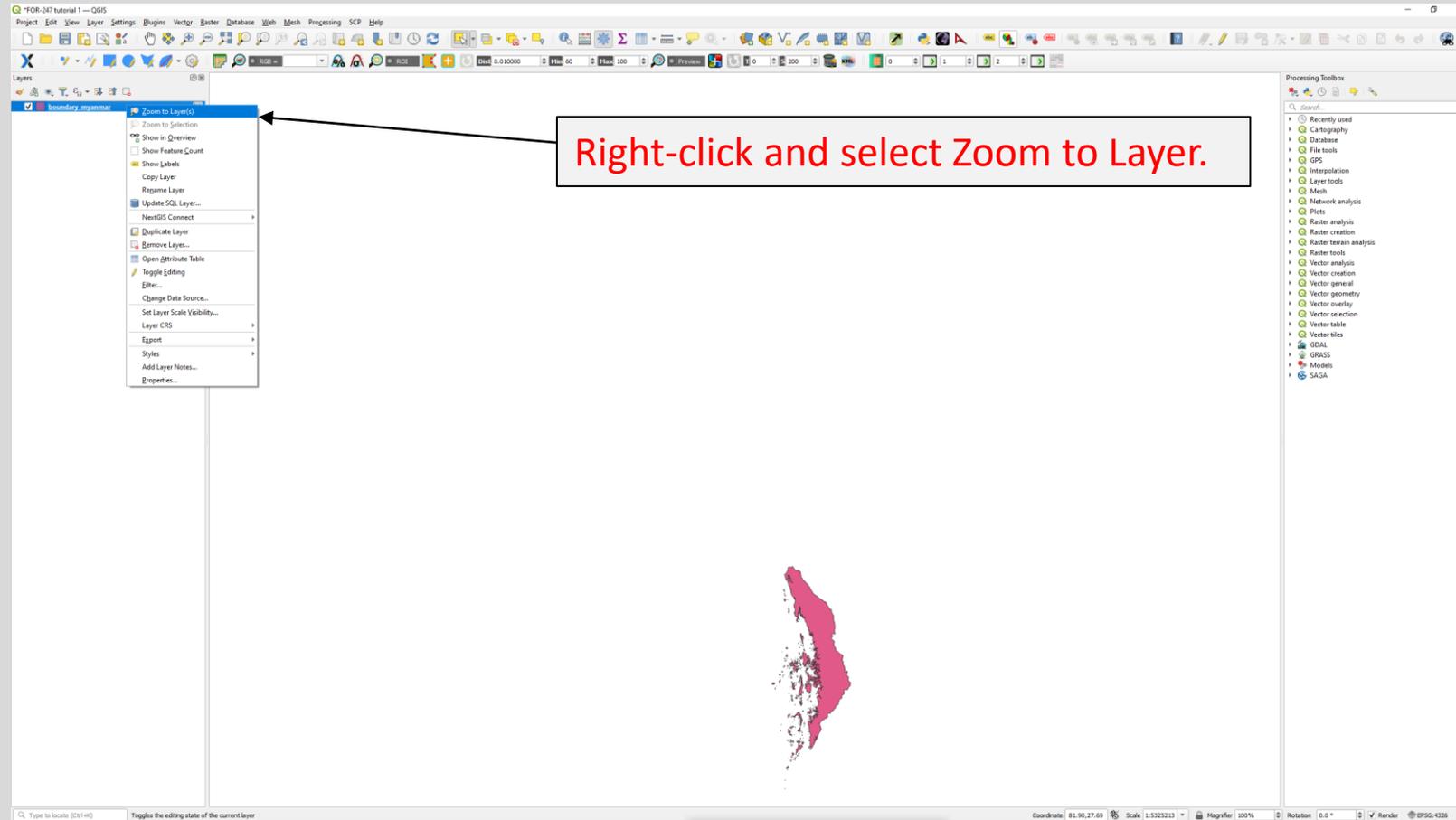
# Filtering the Shapefile to Tanintharyi

Finish the filter expression by typing:  
= 'Tanintharyi'

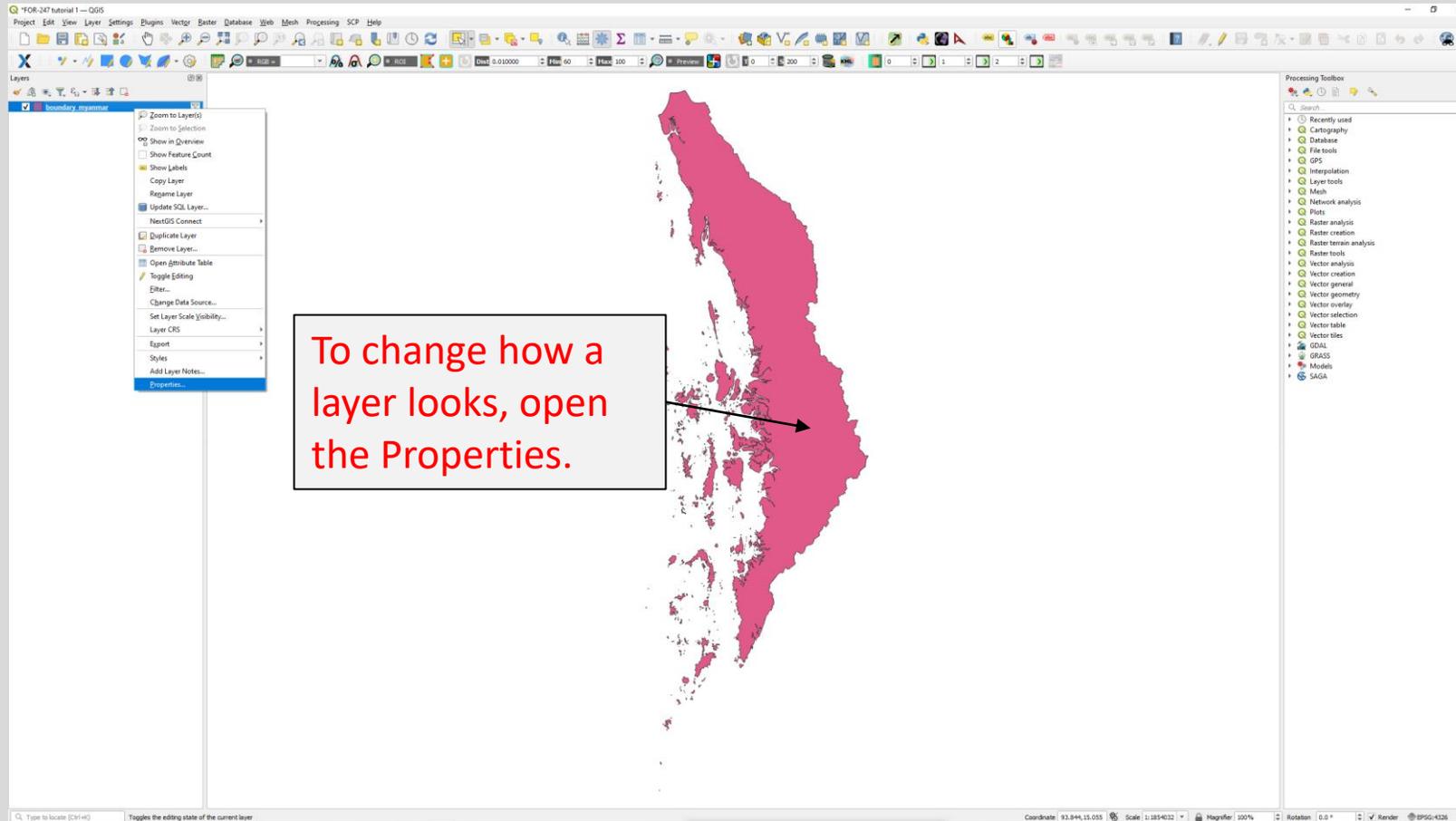
Click OK

The Shapefile has now been filtered to Tanintharyi region.

# Filtering the Shapefile to Tanintharyi



# Styling vector polygon data



# Styling vector polygon data

Click on Simple Fill.

The Symbology menu allows us to customize how we want to style our polygon (i.e., colour, outline etc.)

The screenshot shows the QGIS interface with the 'boundary\_myanmar' layer selected in the Layers panel. The Layer Properties dialog is open, showing the Symbology tab. The 'Simple Fill' option is selected, and the color is set to a bright pink. The dialog also shows various other symbology options like 'gradient plasma', 'gray 3 fill', 'hashed black /', 'hashed black \', 'hashed black X', 'outline blue', 'outline green', 'outline red', 'outline pattern', 'pattern dot black', 'pattern zelda', and 'simple blue fill'. The 'Layer Rendering' section is also visible at the bottom of the dialog.

# Styling vector polygon data

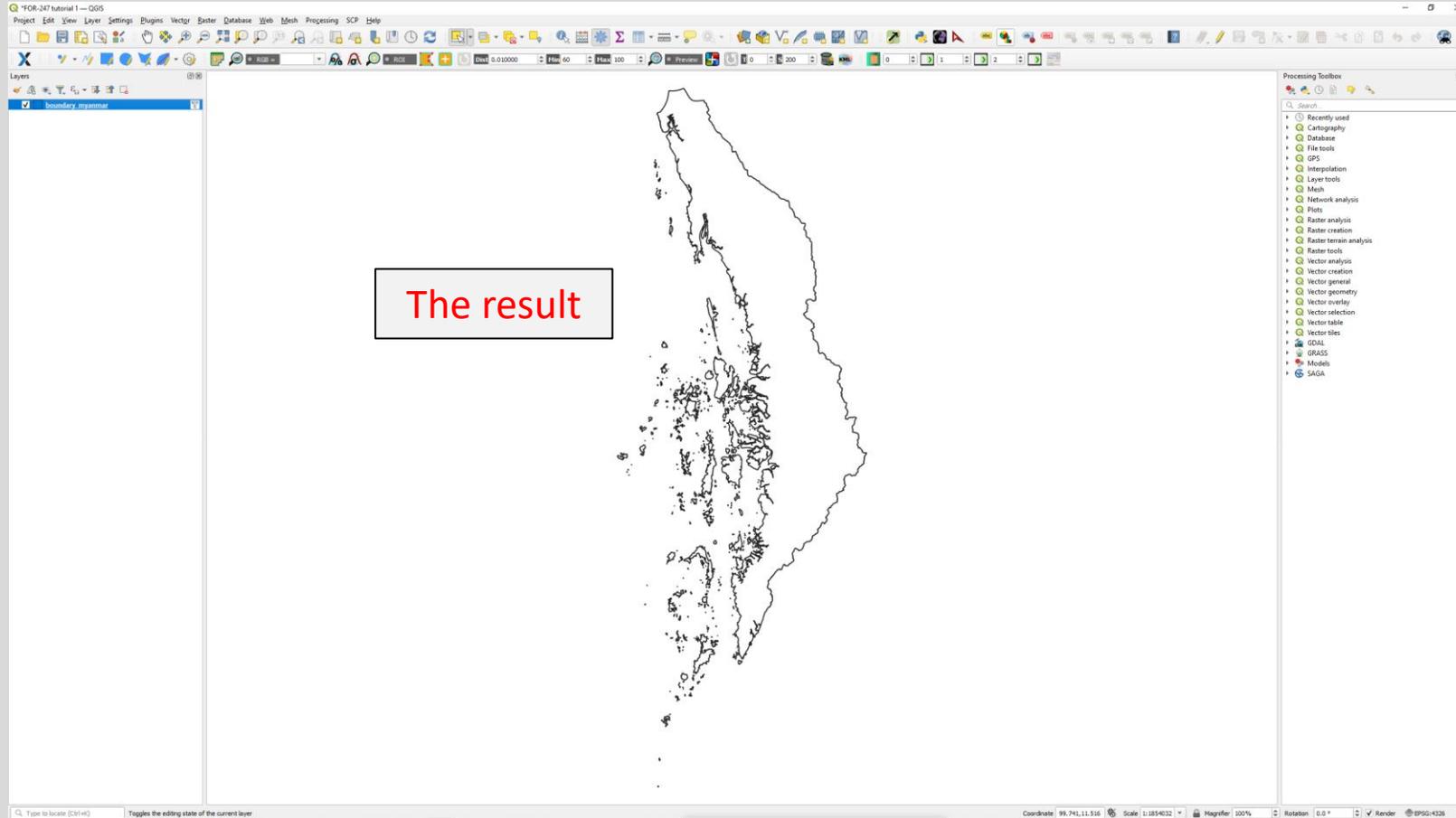
Change the following settings:

- Fill style to No Brush
- Width to 0.5 mm.

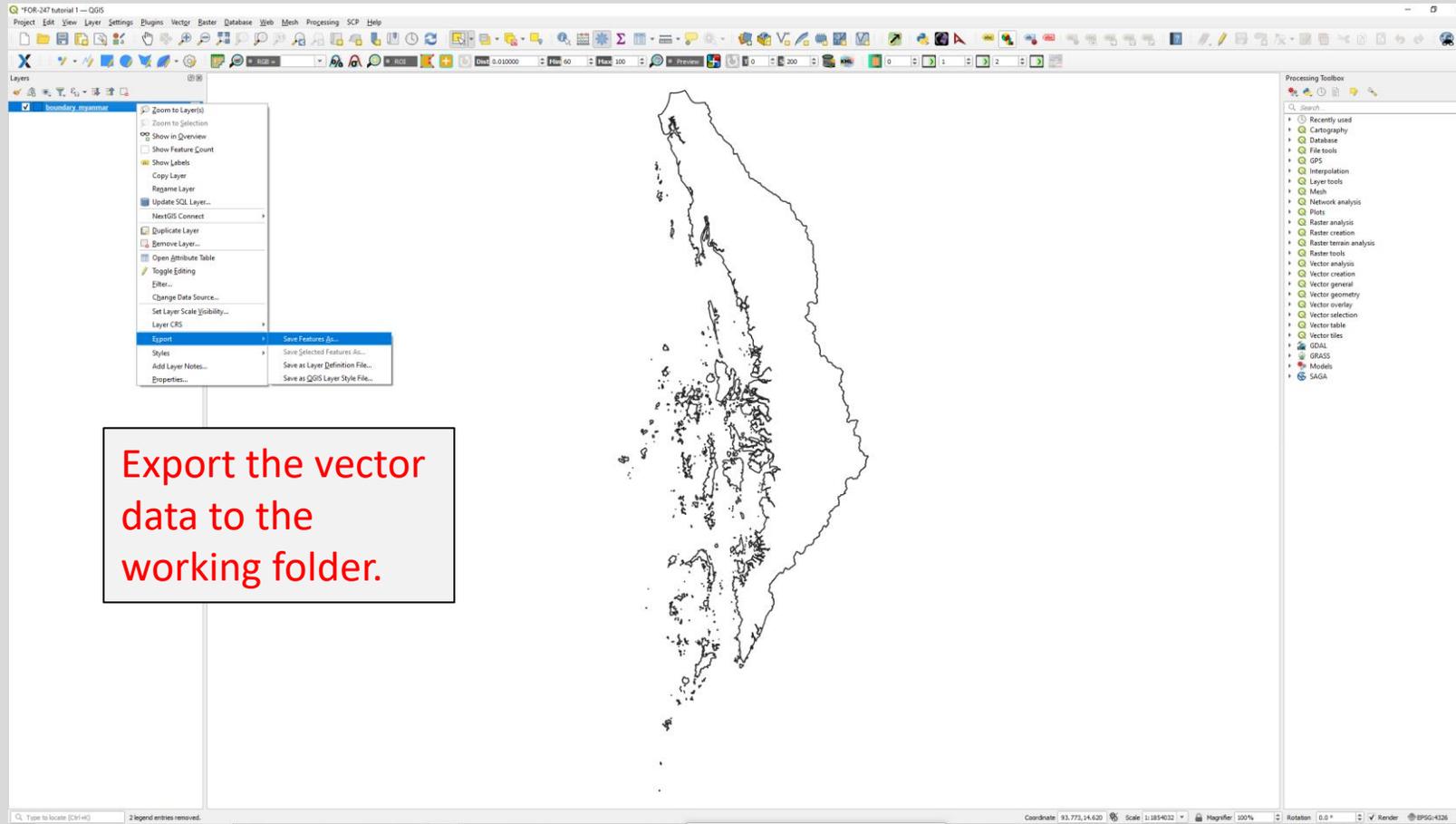
Click OK

The screenshot shows the QGIS interface with a map of Myanmar. The 'Layers' panel on the left shows a layer named 'boundary\_myanmar'. The 'Layer Properties' dialog for this layer is open, showing the 'Symbology' tab. The 'Symbol layer type' is 'Simple Fill'. The 'Fill color' is set to a pink color. The 'Stroke width' is set to 0.500000 millimeters. The 'Stroke style' is 'Solid Line'. The 'Join style' is 'Bevel'. The 'Offset' is set to 0.000000 millimeters. A text box on the left lists settings to be changed: 'Change the following settings:', 'Fill style to No Brush', and 'Width to 0.5 mm.'. A 'Click OK' button is shown at the bottom right of the dialog.

# Styling vector polygon data



# Exporting vector data



# Exporting vector data

The screenshot shows the QGIS interface with a map of a region. A dialog box titled 'Save Vector Layer as...' is open, showing the following settings:

- Format: ESRI Shapefile
- File name: (empty)
- Layer name: (empty)
- CRS: EPSG:4326 - WGS 84
- Encoding: UTF-8
- Save only selected features
- Select fields to export and their export options
- Fields table:

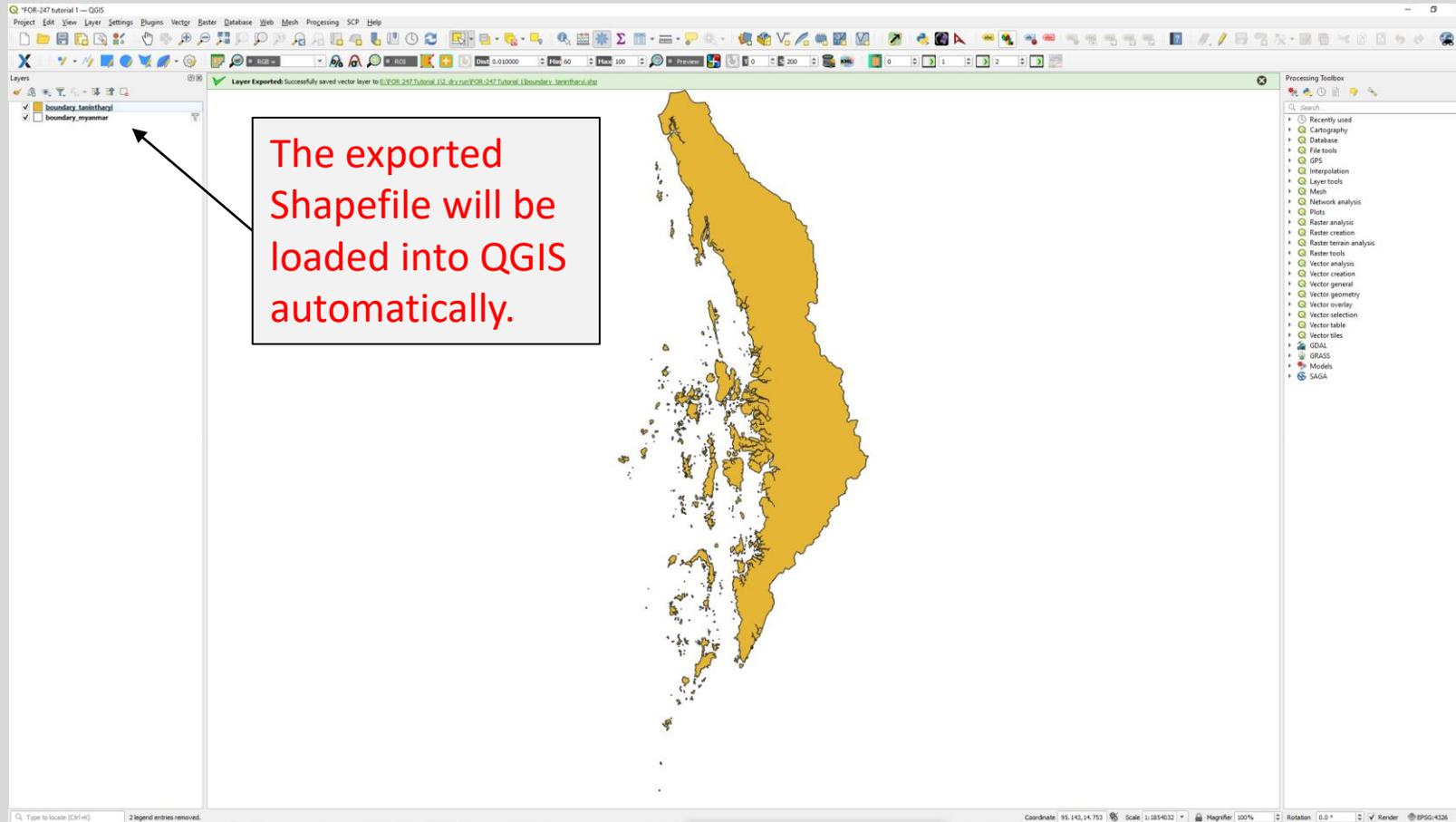
Name	Type
<input checked="" type="checkbox"/> GD_1	String
<input checked="" type="checkbox"/> GD_0	String
<input checked="" type="checkbox"/> COUNTRY	String
<input checked="" type="checkbox"/> NAME_1	String
<input checked="" type="checkbox"/> VARNAME_1	String
<input checked="" type="checkbox"/> NI_NAME_1	String
- Persist layer metadata
- Geometry
- Geometry type: Automatic
- Force multi-type
- Add saved file to map

Annotations in red text boxes point to the 'Format' dropdown and the 'File name' field.

Select ESRI Shapefile as the file format.

Click here to set the file path and name.

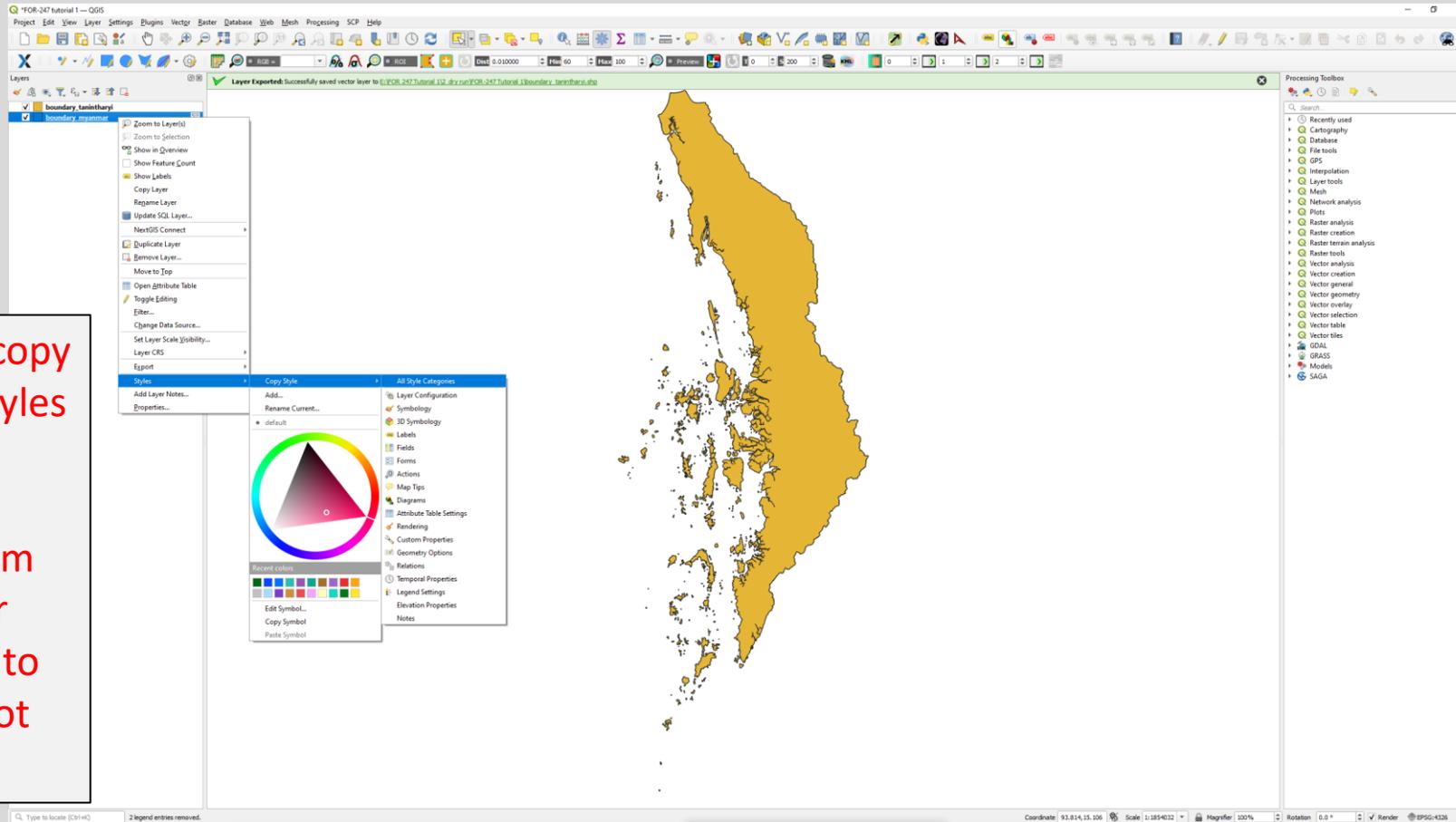
# Exporting vector data



# Exporting vector data

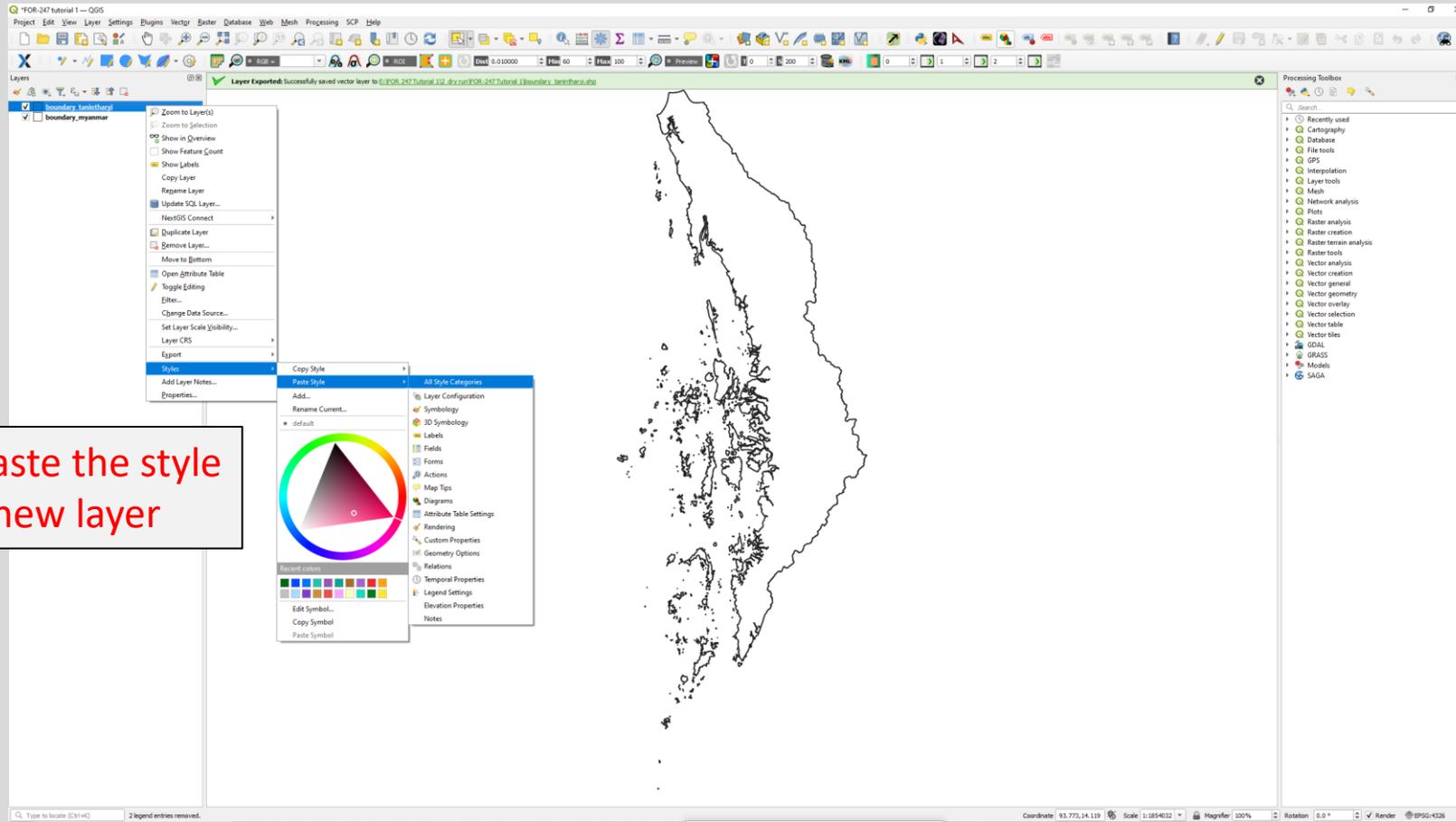
In QGIS, you can copy and paste layer styles and symbologies.

Copy the style from the filtered vector layer and apply it to the one we just got loaded into QGIS.

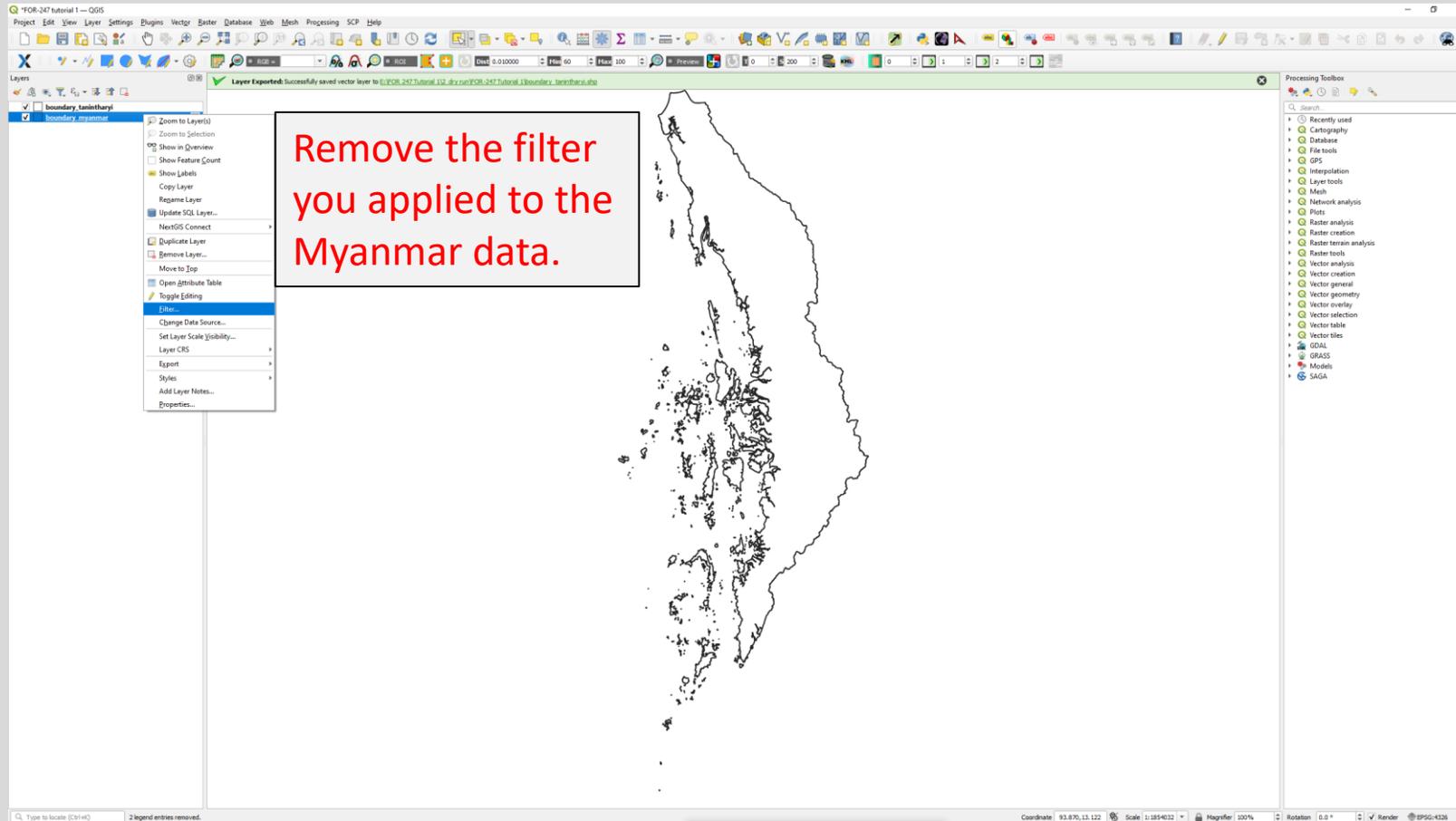


# Exporting vector data

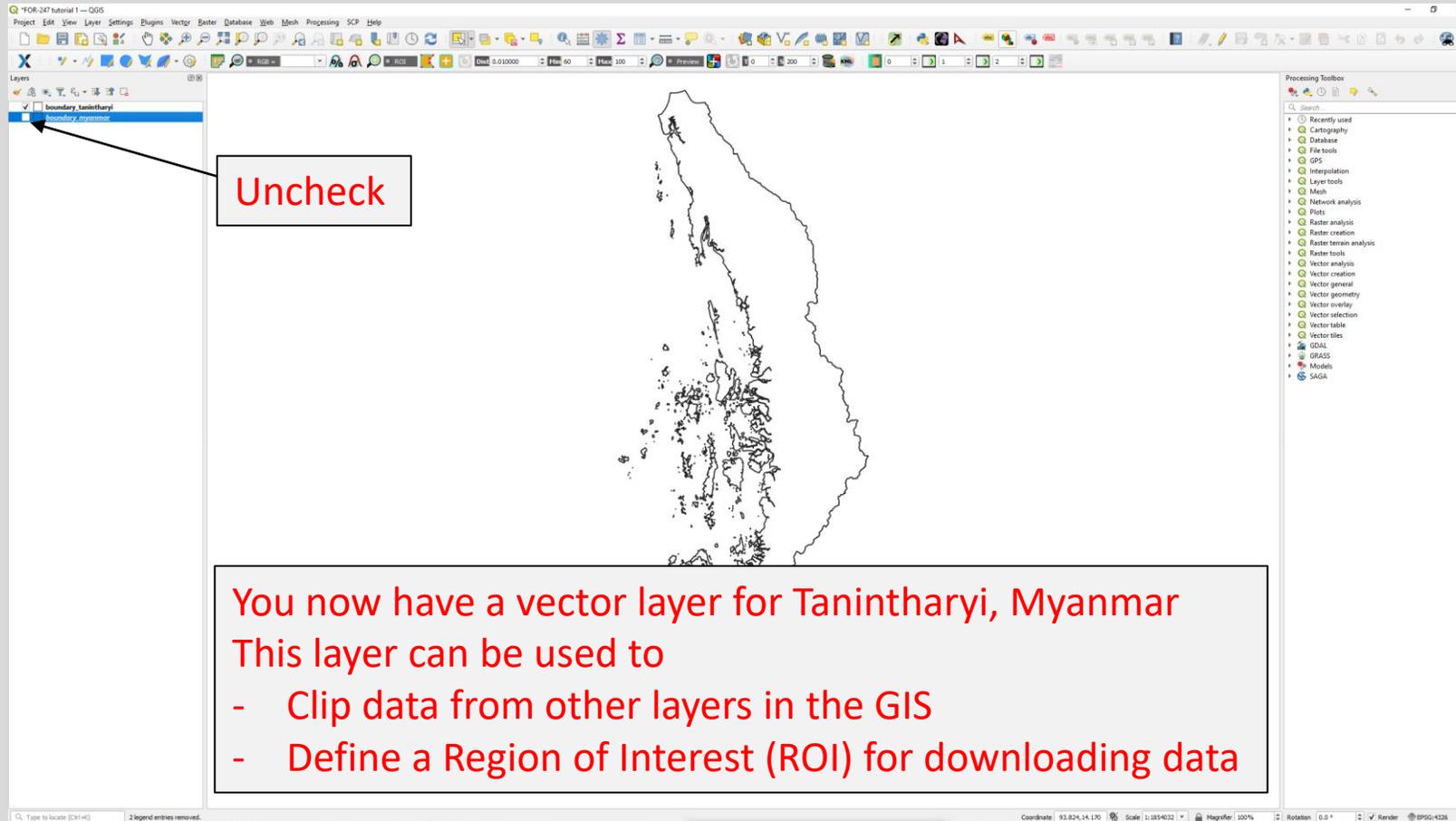
Now paste the style to the new layer



# Removing the Shapefile filter



# Turning off a layer from the canvas



**Uncheck**

**You now have a vector layer for Tanintharyi, Myanmar**  
**This layer can be used to**

- Clip data from other layers in the GIS
- Define a Region of Interest (ROI) for downloading data

Raster data processing

# Loading raster data

Drag-and-drop the 2 land cover files from your working folder into QGIS.

By default, the raster maps will be styled using a grayscale colour ramp.

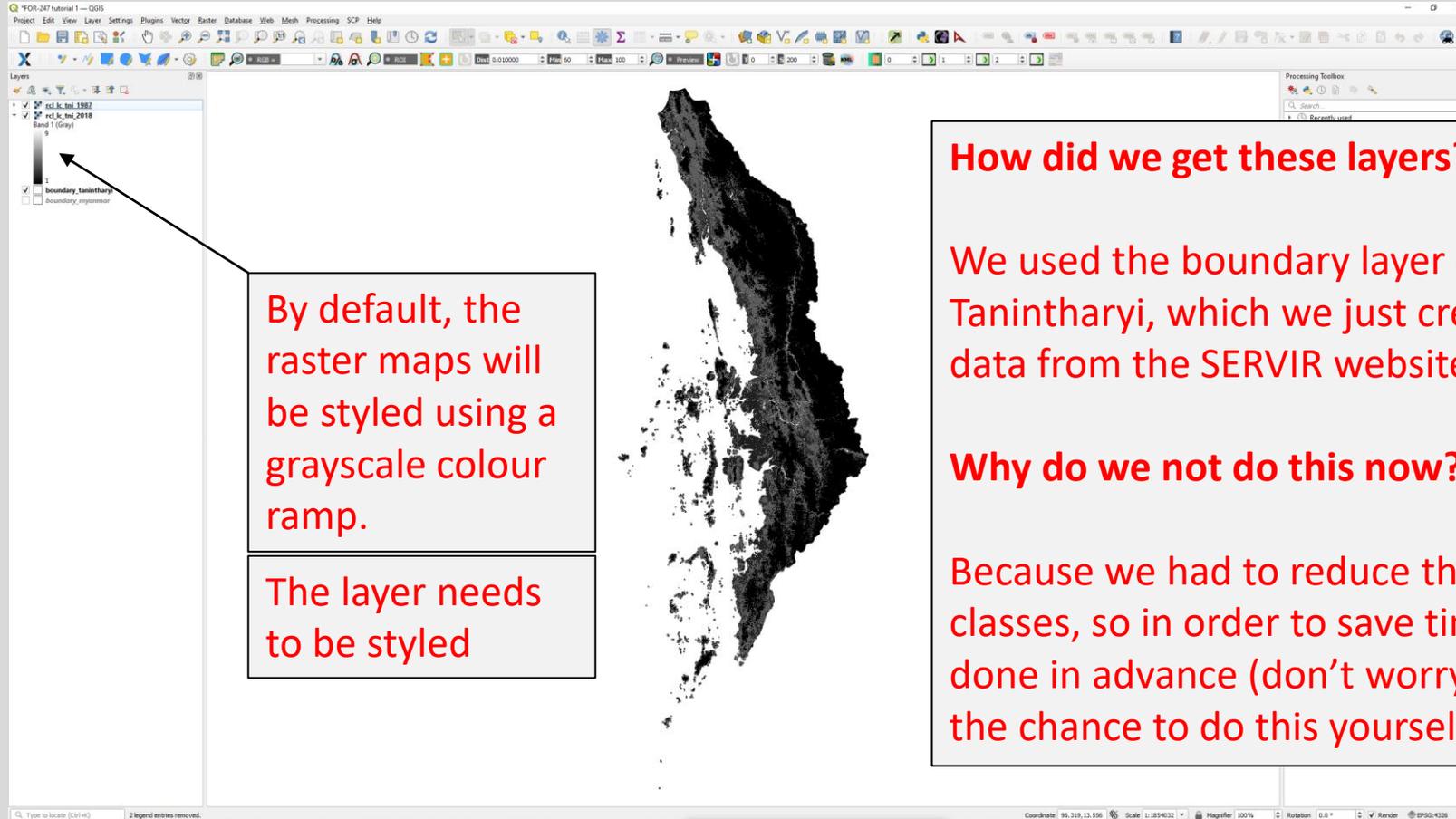
The layer needs to be styled

**How did we get these layers?**

We used the boundary layer of Tanintharyi, which we just created, to clip data from the SERVIR website.

**Why do we not do this now?**

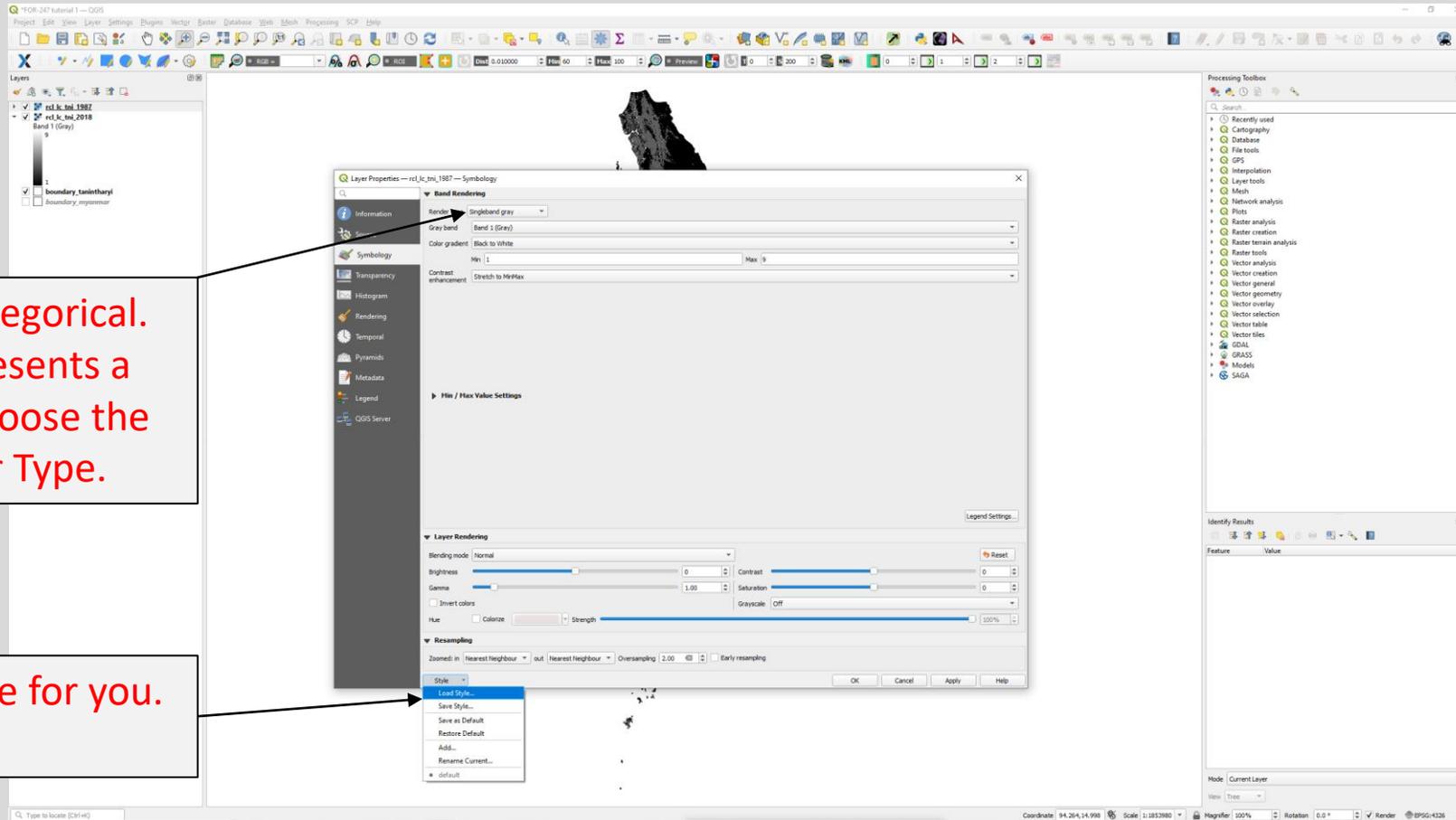
Because we had to reduce the number of classes, so in order to save time it was done in advance (don't worry, you will get the chance to do this yourself later)



# Styling the landcover layers

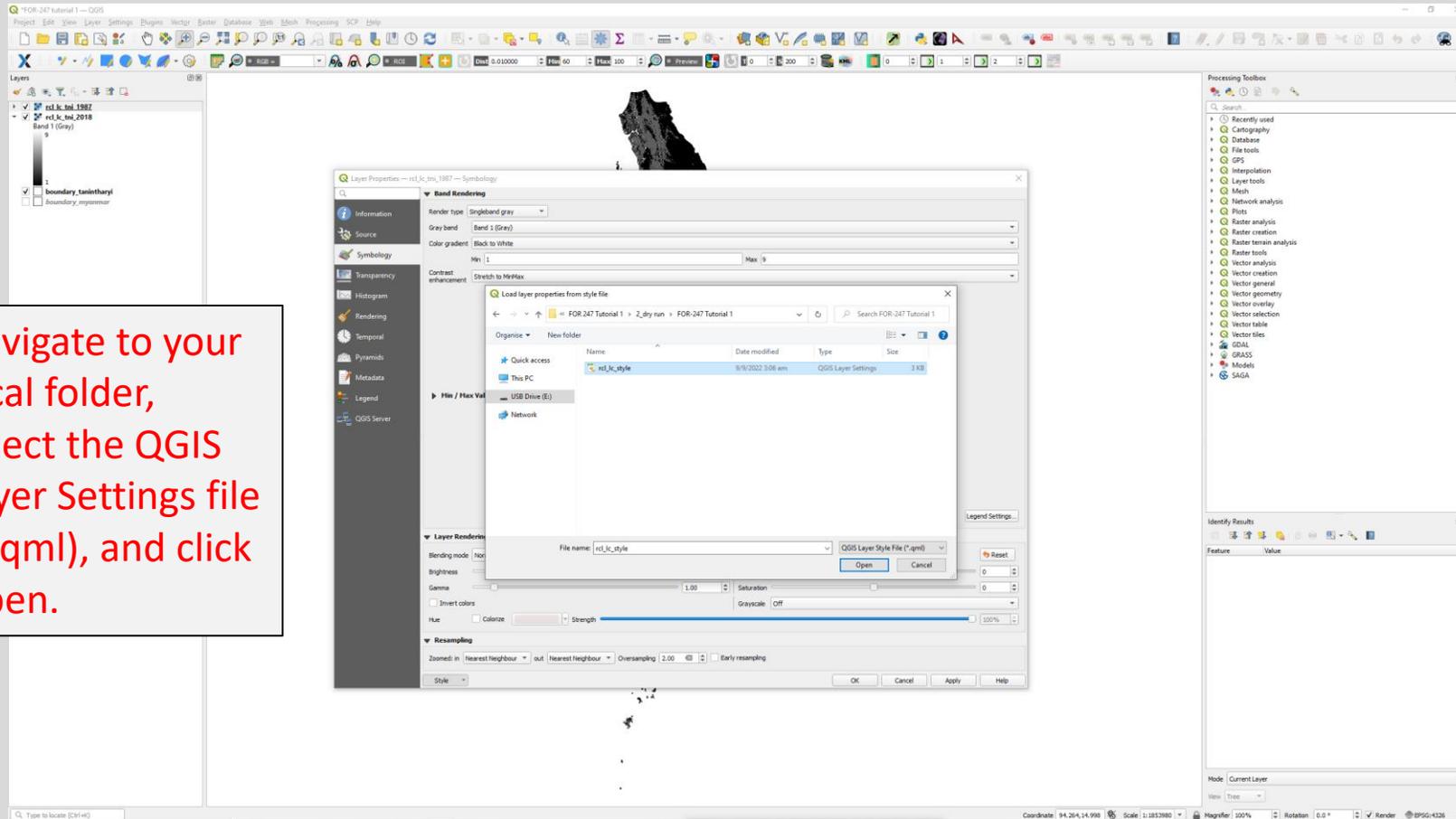
The map data is categorical.  
Each category represents a  
land cover type. Choose the  
appropriate Render Type.

We made a GIS style for you.  
Load it.



# Styling the landcover layers

Navigate to your local folder, select the QGIS Layer Settings file (\*.qml), and click Open.



# Styling the landcover layers

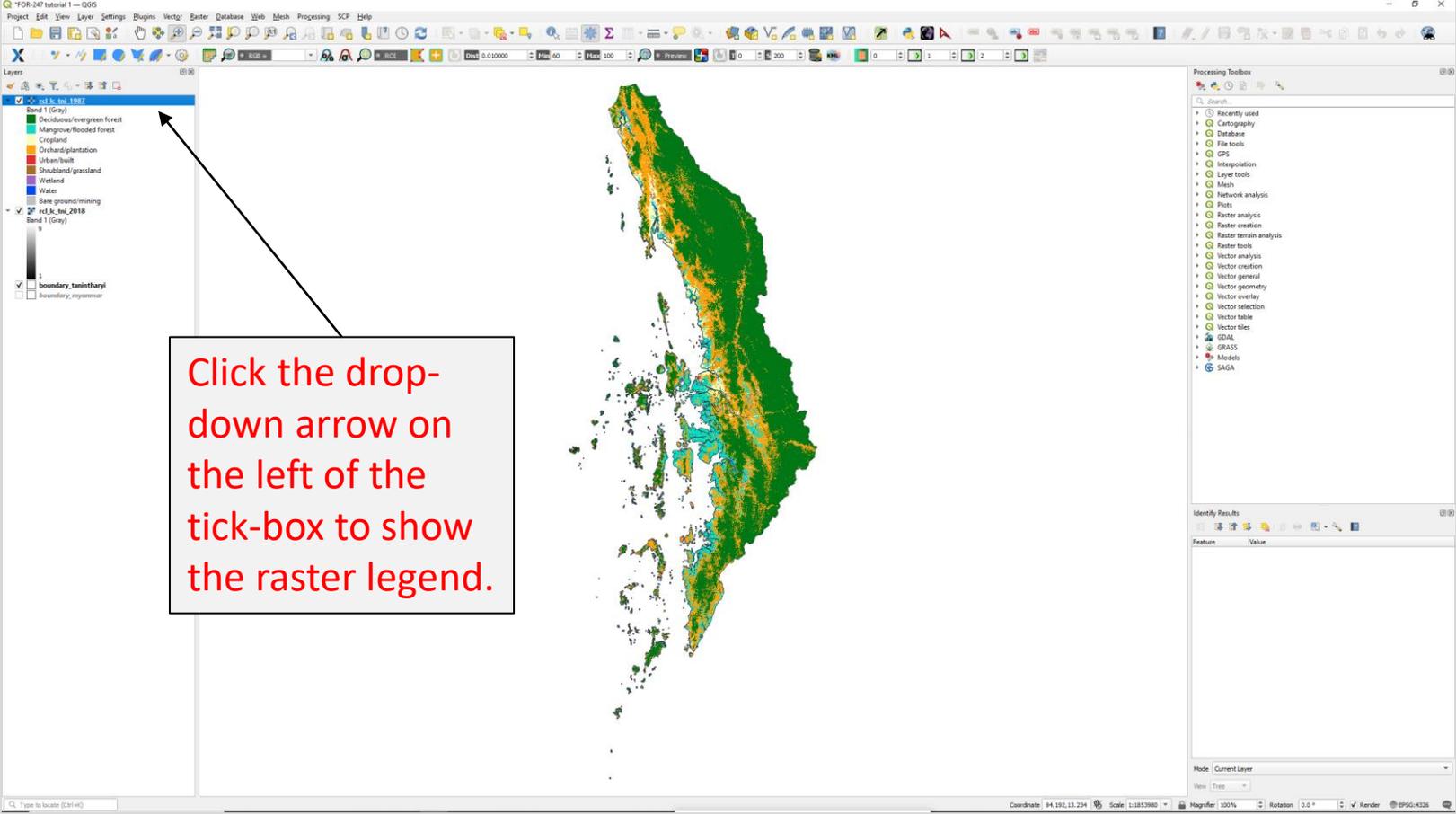
Look through the raster colours and labels for pixel values 1–9. Click OK.

Recall that the original SERVIR data has 17 classes. These were reduced to 9 for your convenience.

Value	Color	Label
1	Green	Deciduous/evergreen forest
2	Cyan	Mangrove/flooded forest
3	Yellow	Cropland
4	Orange	Orchard/plantation
5	Red	Urban/built
6	Brown	Shrubland/grassland
7	Purple	Wetland
8	Blue	Water
9	Gray	Bare ground/mining

Visually interpreting land cover  
change

# Visually interpreting land cover change



Click the drop-down arrow on the left of the tick-box to show the raster legend.

The screenshot shows the QGIS interface with a map of a coastal region. The Layers panel on the left lists several layers, including a raster layer named 'Band 1 (Gray)'. A callout box points to the tick box next to this layer, with red text indicating that clicking the drop-down arrow on the left of the tick box will show the raster legend. The raster legend is visible in the Layers panel, showing a color-coded legend for the raster data. The legend includes categories such as Deciduous/evergreen forest, Mangrove/flooded forest, Cropland, Orchard/plantation, Urban/built, Shrubland/grassland, Wetland, Water, and Bare ground/mining. The map shows a coastal region with various land cover types, including forest, cropland, and urban areas. The Processing toolbox is visible on the right side of the interface.

# Visually interpreting land cover change

The screenshot shows the QGIS interface with a land cover map of a coastal region. The map displays various land cover types in different colors: green for forest, yellow for agriculture, and blue for water. A context menu is open over the map, and a red text box is overlaid on the bottom left.

**Copy the raster style from the 1987 map.**

The context menu options include: Zoom to Layer(s), Show in Overview, Copy Layer, Regame Layer, Zoom to Native Resolution (100%), Stretch Using Current Extent, NextGIS Connect, Duplicate Layer, Remove Layer..., Move to Bottom, Change Data Source..., Set Layer Scale (Visibility)..., Layer CRS, Export, Style, Copy Style, Paste Style, Add..., Rename Current..., and default.

The Processing toolbox on the right lists various tools such as Recently used, Cartography, Database, File tools, GPS, Interpolation, Layer tools, Mesh, Network analysis, Plots, Raster analysis, Raster creation, Raster terrain analysis, Raster tools, Vector analysis, Vector creation, Vector geometry, Vector generation, Vector selection, Vector table, Vector tools, GDAL, GRASS, and SAGA.

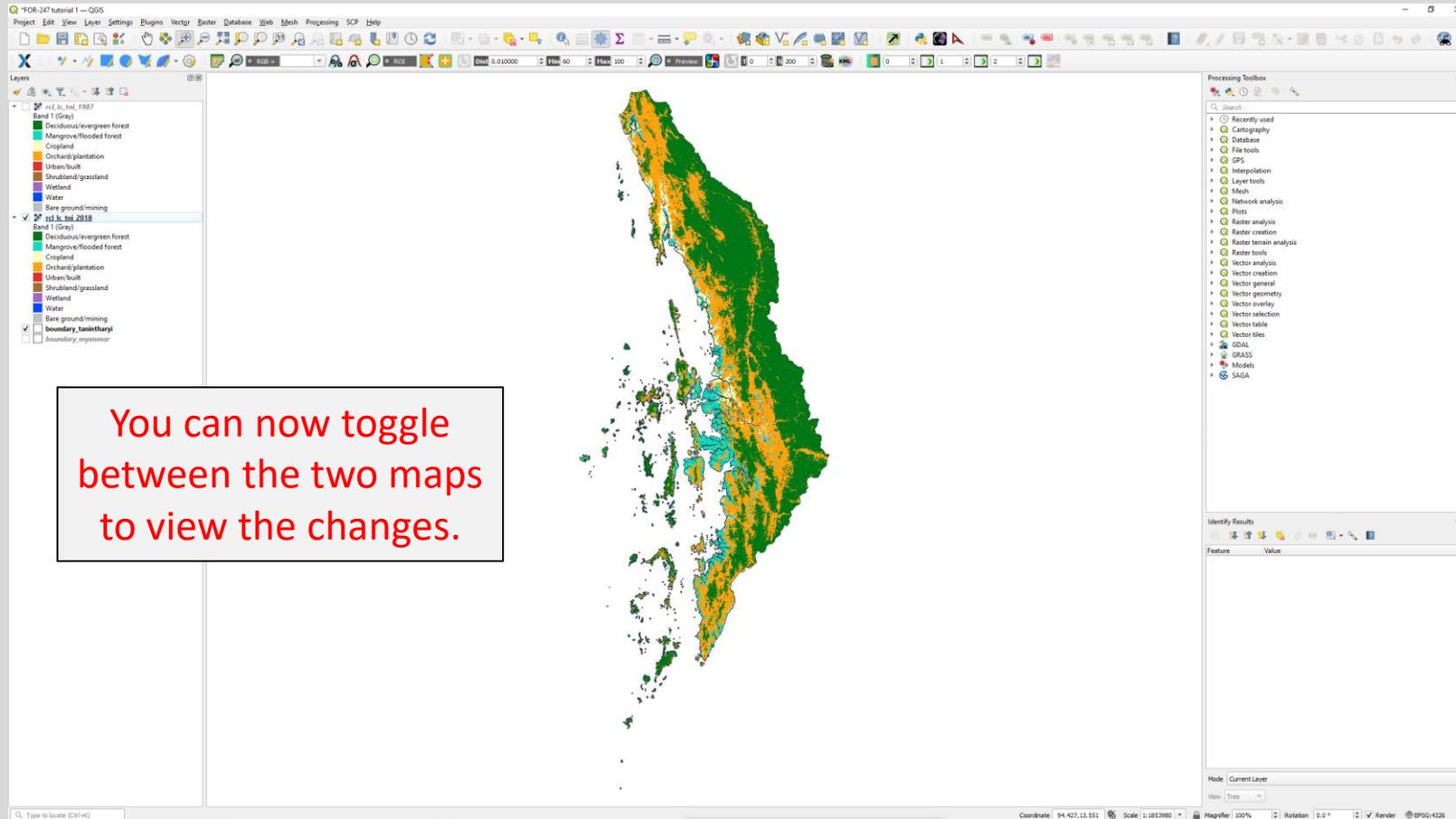
The Identify/Results panel at the bottom right shows a table with columns for Feature and Value.

The status bar at the bottom indicates the coordinate system (EPSG:4326), scale (1:1853980), and zoom level (100%).

# Visually interpreting land cover change

Paste the copied raster style to the 2018 map.

# Visually interpreting land cover change



# Visually interpreting land cover change

You now have a GIS project that is ready for the quantification of land cover change.