USING SPATIAL INFORMATION TO SUPPORT DECISIONS ON SAFEGUARDS AND MULTIPLE BENEFITS FOR REDD+

STEP-BY-STEP TUTORIAL: VERSION 2.1
INTRODUCTION TO QGIS – THE BASICS
GETTING STARTED WITH OPEN SOURCE USING QGIS 3.16

Working Document

UN-REDD PROGRAMME

Food and Agriculture Organization of the United Nations

UNDP

UN environment programme

The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme assists developing countries to prepare and implement national REDD+ strategies, and builds on the convening power and expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP).

Since its inception in 2008, UN-REDD, the UN interagency flagship programme on forests and climate, has, with support of Norway and other donors, contributed to slowing deforestation, promoted as a guiding principle the informed and meaningful involvement of all stakeholders, including indigenous peoples, local communities and women, established firm social and environmental safeguards, and contributed to the sustainable development of its 65 partner countries.

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is a global Centre of excellence on biodiversity. The Centre operates as a collaboration between the United Nations Environment Programme and the UK-registered charity WCMC. Together we are confronting the global crisis facing nature.

These training materials have been produced from materials generated for webinars held with partners in Myanmar to aid the production of ecosystem service and biodiversity using open source GIS software and models, as part of the UN-REDD project 'Integrating mangroves sustainable management, restoration and conservation into REDD+ implementation in Myanmar. This work was funded by the UN REDD Programme and the Norwegian Agency for Development Cooperation (NORAD).

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1. Introduction

REDD+ is a voluntary climate change mitigation approach that has been developed by Parties to the UNFCCC. It aims to incentivize developing countries to reduce emissions from deforestation and forest degradation, conserve forest carbon stocks, sustainably manage forests and enhance forest carbon stocks. This will involve changing the ways in which forests are used and managed, and may require many different actions, such as protecting forests from fire or illegal logging, or rehabilitating degraded forest areas.

REDD+ has the potential to deliver multiple benefits beyond carbon. For example, it can promote biodiversity conservation and secure ecosystem services from forests such as water regulation, erosion control and non-timber forest products (NTFPs). Some of the potential benefits from REDD+, such as biodiversity conservation, can be enhanced through identifying areas where REDD+ actions might have the greatest impact using spatial analysis and other approaches.

Open-source GIS software can be used to undertake spatial analysis of datasets of relevance to multiple benefits and environmental safeguards for REDD+. Open-source software is released under a license that allows software to be freely used, modified, and shared (http://opensource.org/licenses). Therefore, using open-source software has great potential in building sustainable capacity and critical mass of experts with limited financial resources.

The purpose of this tutorial series is to help participants in technical working sessions, who are already skilled in GIS, to undertake analyses that are relevant to REDD+. The tutorials have been used to build capacity in a number of countries to produce datasets and maps relevant to their spatial planning for REDD+, and to develop such map products. Maps developed using these approaches appear in a number of publications whose aim is to support planning of strategy options that enhance biodiversity and ecosystem services as well as delivering climate change mitigation (see below). There is of course no requirement for countries to use the approaches described in these tutorials.

Where countries have identified biodiversity conservation as a goal for REDD+, and to be consistent with the Cancun safeguards for REDD+ on protecting biodiversity, it is useful to identify areas where specific REDD+ actions are feasible and can protect threatened species. It may also be useful to identify areas outside forest where threatened species may be vulnerable to the displacement of land-use change pressures or to afforestation.

This tutorial provides a brief introduction to QGIS, a desktop GIS software, and will help users get started with using QGIS. The purpose of the tutorial is to help bring participants in technical working sessions, who are already skilled in GIS, quickly up to speed on the core functionality of the QGIS software to enable them to navigate the system, use the basic functions and provide the essential basics that will enable them to quickly move on to more advanced analyses that are relevant to REDD+.

This tutorial has been used in a number of working sessions with countries to support countries in the transition to open-source software for use in spatial planning for REDD+. A few examples are listed below:

- Spatial analysis to support REDD+ planning in Mongolia: Joint working sessions report, 2016 (https://www.un-redd.org/document-library/spatial-analysis-support-redd-planning-mongolia-joint-working-sessions-report)
- Nigeria's REDD+ Readiness Programme - Beyond Carbon: Consultation & joint working session on spatial planning for REDD+ in Cross River State, November 2014. (https://www.un-redd.org/document-library/nigerias-redd-readiness-programme-beyond-carbon-consultation-joint-working-session)

2. QGIS – an open-source desktop GIS

2.1. QGIS: Brief introduction to QGIS open-source desktop GIS

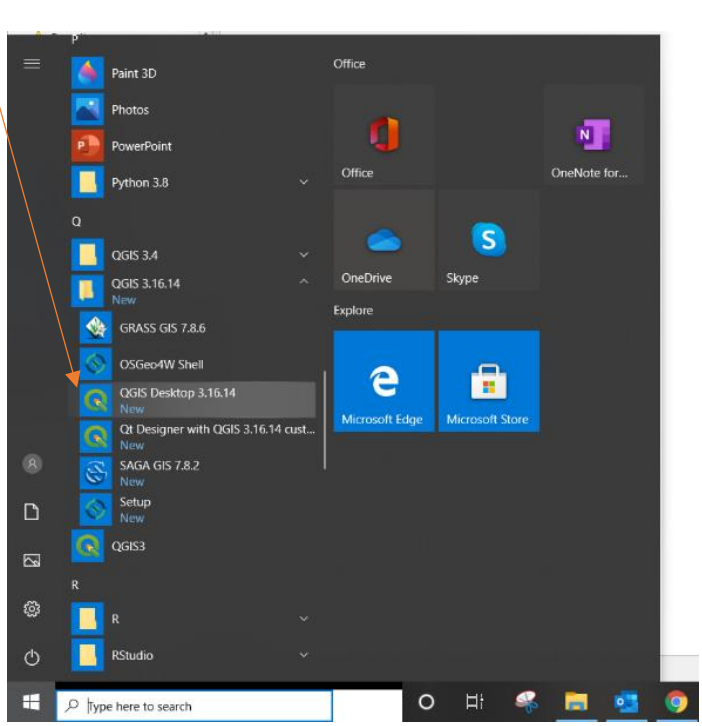
QGIS is a free and open-source desktop GIS comparable to proprietary GIS software such as ArcGIS. It has the advantage of being able to run on multiple platforms (Linux, Unix, Mac OSX, Windows and Android operating systems). It supports vector and raster processing and can access and utilize tools available in other open-source GIS packages.

QGIS can:

- View geographic information
- Edit geographic information
- Present geographic information (create maps and figures)
- Analyse geographic information
- Be extended in its functionality (through plugins and scripts)

One of the advantages of QGIS is that it provides access to other open-source GIS and remote sensing software through its processing framework. It integrates methods and tools from other open-source software into the QGIS interface, e.g. GRASS, SAGA and GDAL tools and R scripts. It provides a wealth of analysis tools that can be accessed from a single location. Tools can be run individually or through a graphical user interface (GUI) for processing workflows, which is comparable to the ESRI ArcGIS Toolbox. It also has a Graphical Modeller which is similar to the ESRI ArcGIS Model builder environment.

a. Click on the **Start Icon >> scroll or search for 'QGS Desktop 3.16'** and click on the icon to open QGIS.



2.2. Understanding Coordinate Reference Systems (CRS) in QGIS

Before adding any data to QGIS it is important to understand how projection systems (coordinate reference systems) work in the software. This is a VERY IMPORTANT section as there are a number of places where projections can be set or altered in QGIS. Knowledge of how projections work in QGIS is needed to avoid errors being introduced.

The CRS of a new project will automatically be set to the CRS of the first layer added. If you then add layers in another CRS they will be automatically shown in the project CRS, but they will NOT actually be projected to this CRS. It is known as 'on-the-fly- projection when a layer in one CRS is being displayed in another without actually projecting the layer to another CRS.

2.2.1. Changing the CRS of the current project

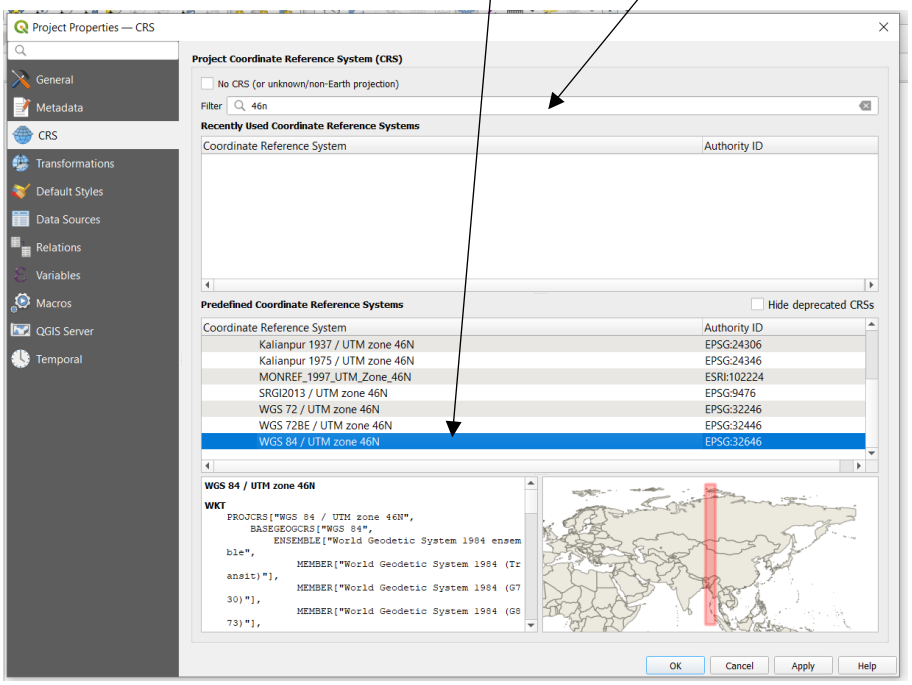
If needed, you can set the current project to a different CRS. This does NOT project the data, it just displays them in the chosen CRS.

a. To set the CRS for the current project click on the **CRS icon** next to EPSG in the bottom right hand corner of the QGIS canvas.

The CRS window appears.

b. The CRS was set to EPSG: 4326. Search for your **chosen projection**, in this case **UTM Zone 46N. Select the appropriate CRS from the list.**

c. **Click OK**

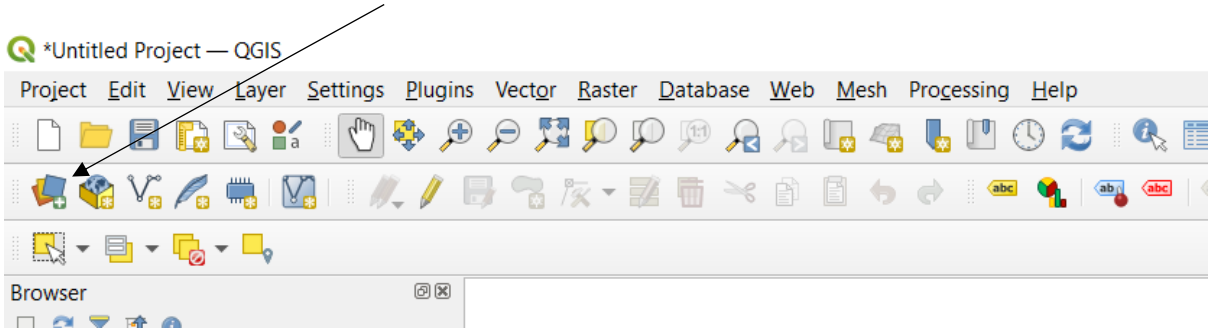


2.2.2. Adding and projecting vector and raster data

If you are undertaking area analysis, data will need to be projected to an equal-area projection (e.g. UTM or Lambert Azimuthal Equal Area) and not just projected on-the-fly. Using an equal-area projection allows the true area to be calculated. Unlike some other GIS software, all the datasets being used in any one analysis must be in exactly the same projection.

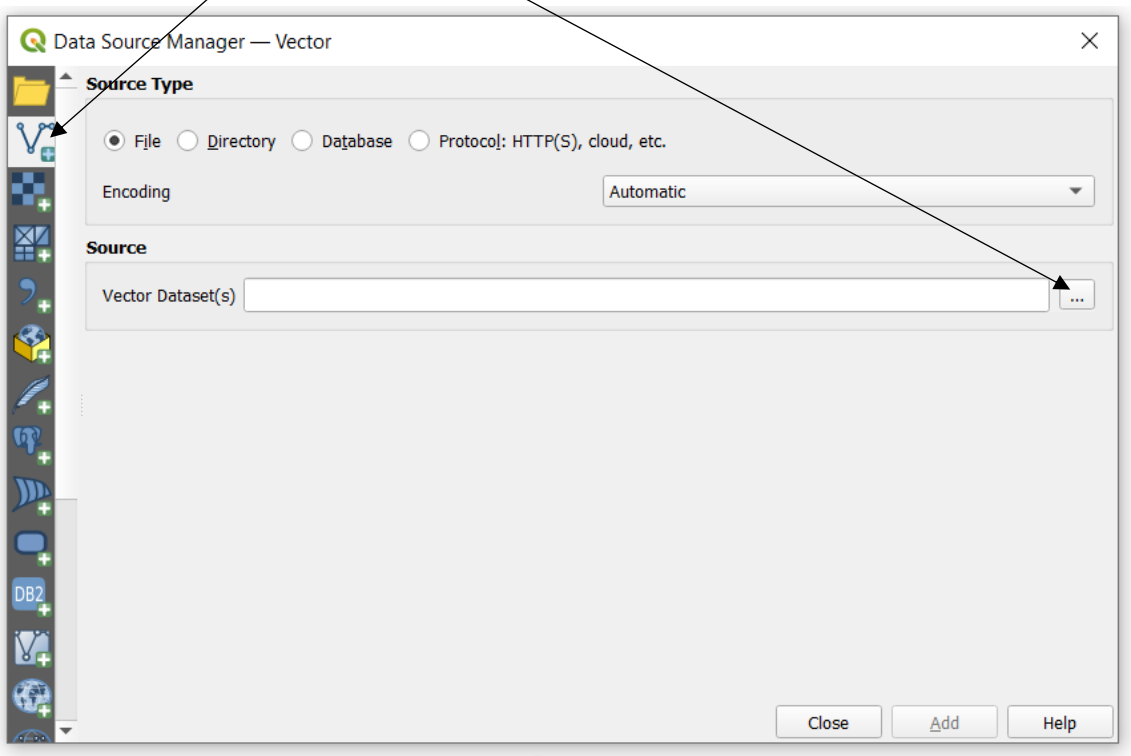
2.2.3. Adding a vector layer

a. Click the **Data Source Manager icon**  to add vector layer to the current project.

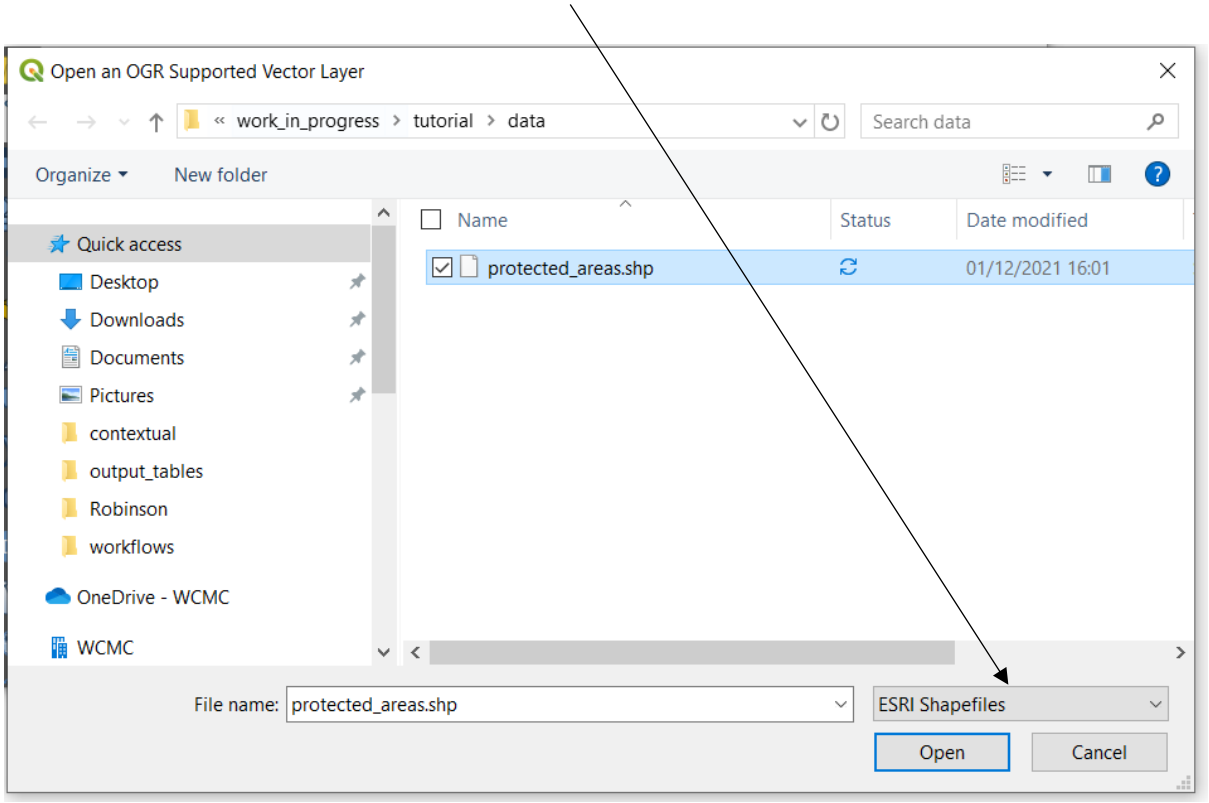


b. Make sure the vector panel is selected

c. Click browse to select dataset



d. Change the File type to **ESRI shapefile**



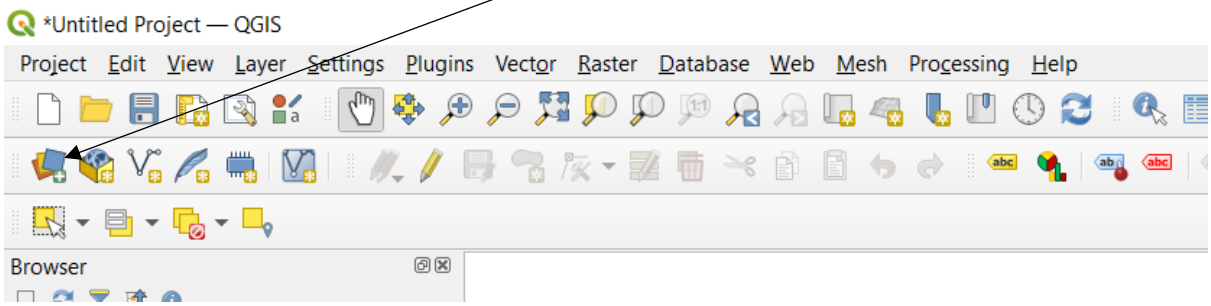
e. Browse to the folder containing the shapefile to add, i.e. in this example a file called **protected_areas.shp. Click on the file** to select it.

f. Click **Open**

g. Then Click **add**

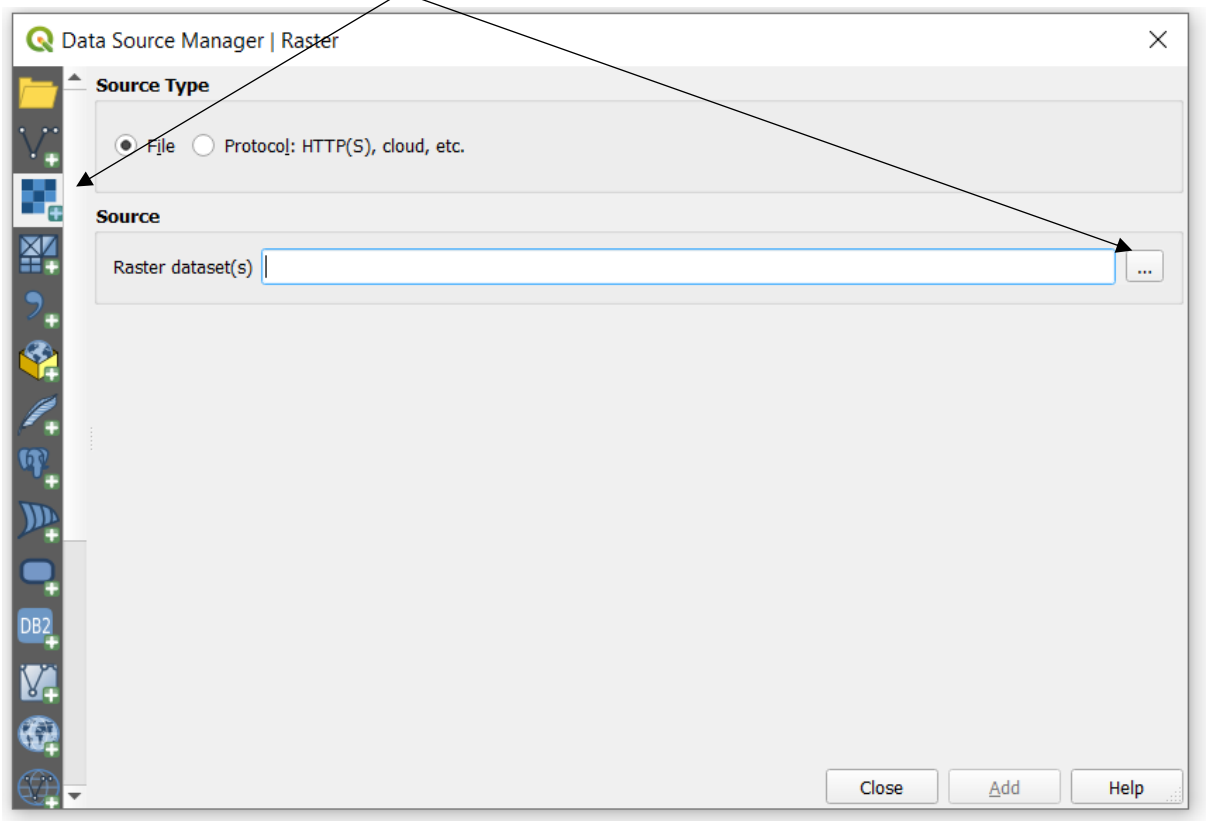
2.2.4. Adding a raster layer

a. Click the **Data Source Manager icon**  to add a raster layer to the current project



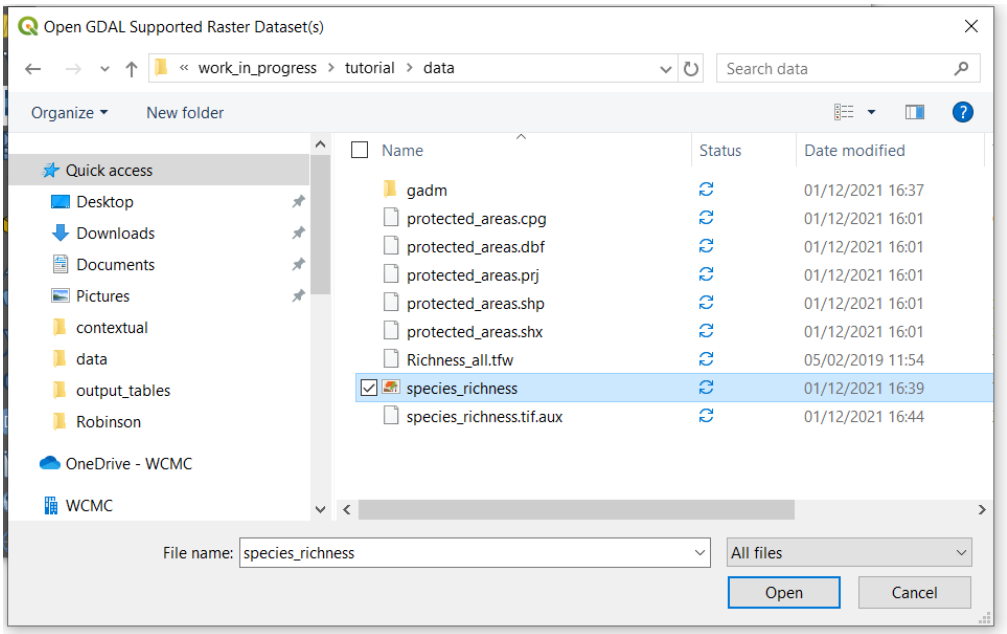
b. Make sure the raster panel is selected

c. Click browse to select dataset



d. Leave file type as **All files,** rasters of all different types can then be added.

e. Browse to the folder containing the raster to add, i.e. in this example a file called **species_richness. Click on the file** to select it.



f. Click **Open**

g. Then Click **add**

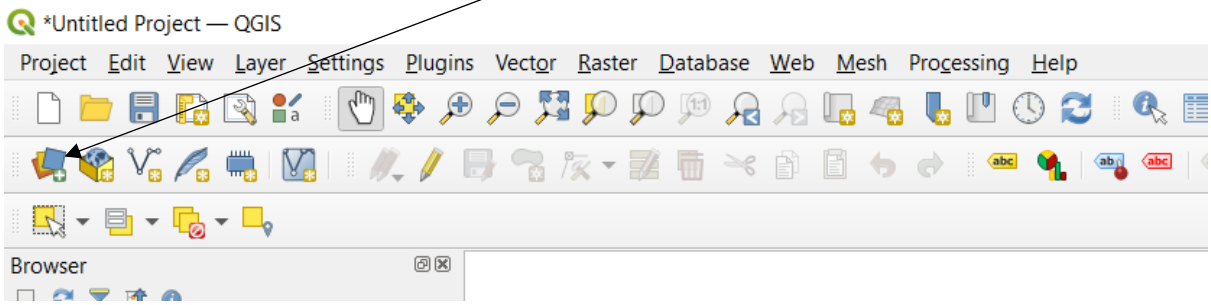
2.2.5. Adding a delimited text layer

Tabular data can be added to QGIS by adding it as a Vector Layer (and mapped as points if location information is included).

To add a delimited text file to be uploaded as a layer in QGIS:

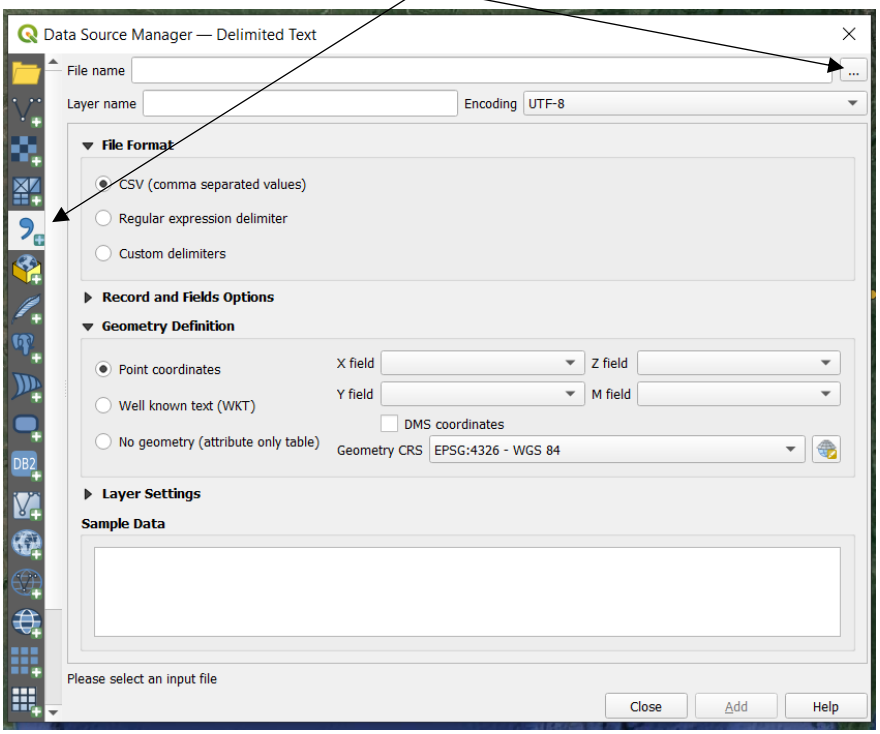
- The text file must be formatted so that the first line of the text file is a delimited header row of field names;
- The data must contain X (longitude) and Y (latitude) coordinate fields (formatted as numeric but in any CRS);
- The CRS of the XY coordinates must be known.

a. Click the **Data Source Manager icon**  to add text layer to the current project

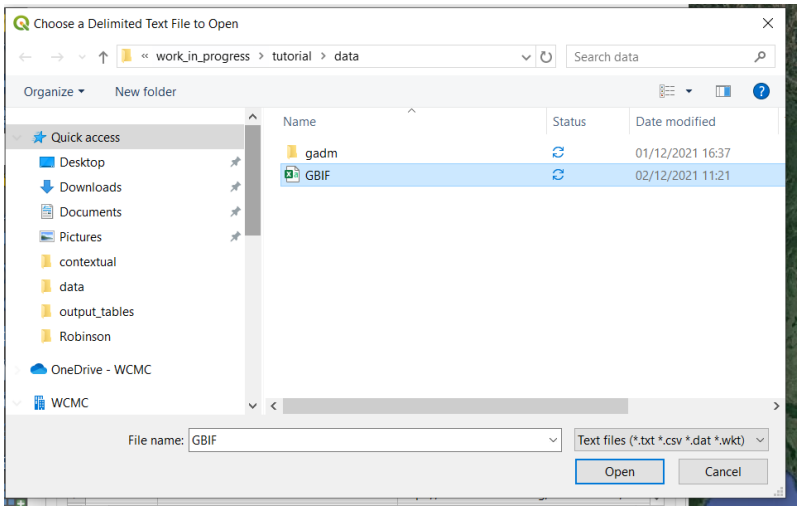


b. Make sure the **Delimited Text** panel is selected

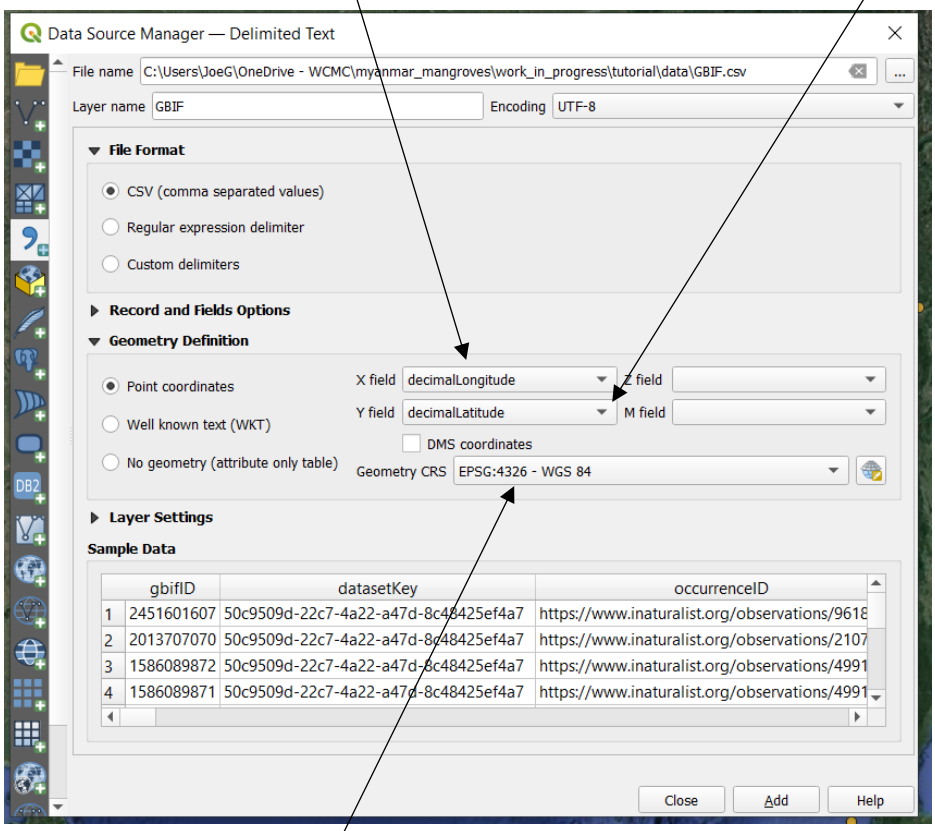
c. Click browse to select dataset



d. Browse to the folder containing the csv to add, i.e. in this example a file called **GBIF.csv. Click on the file** to select it.



e. Check that the **X field** contains the longitude column and the **Y field** contains the latitude column (these are columns that are in the csv sheet)



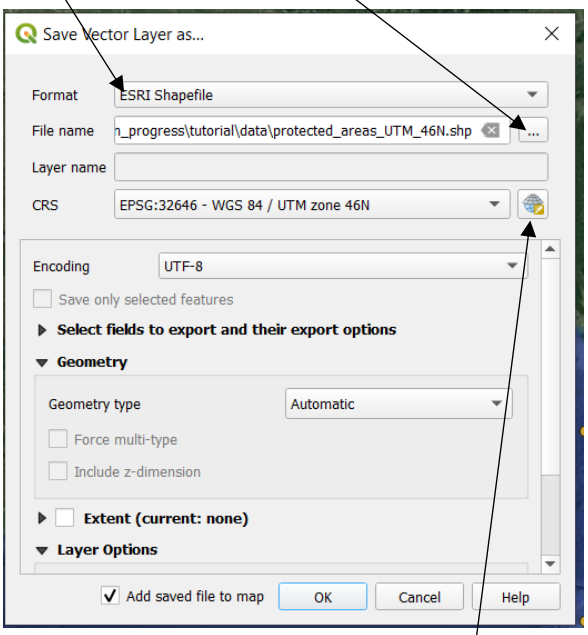
f. Ensure the **Geometry CRS** is set to match the CRS of the coordinates, in this example WGS84

g. Click add and the points should appear on the map

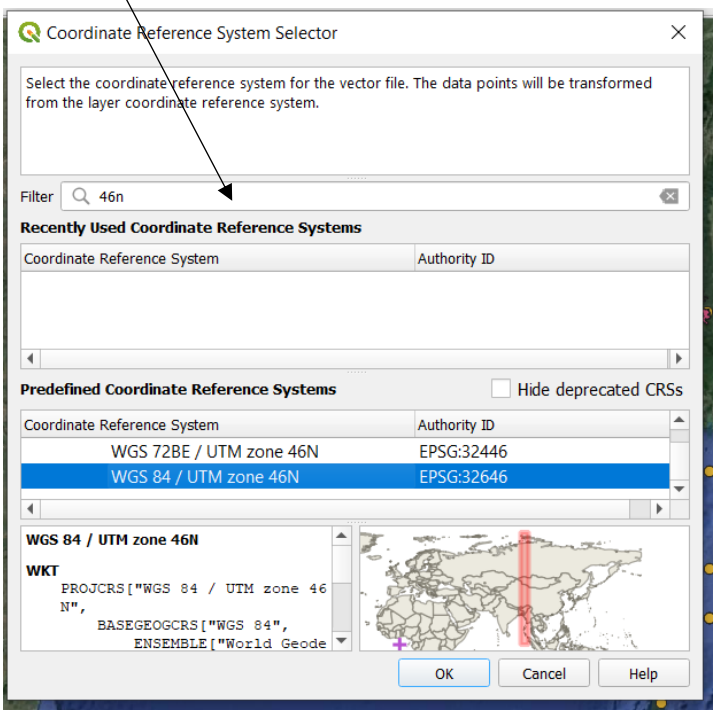
h. The layer is currently only temporary, to save it right click on the layer and go **Export >> Save Features As.** This will produce a new layer.

2.2.6. Projecting data / saving data to a new CRS

a. **Right-click** on the dataset to project (in this example protected_areas.shp). Click **Export >> Save Features As**.
b. Make sure ESRI Shapefile format is selected
c. Browse to the location you want to save the new file and give the file an appropriate name. It helps to include the projection in the filename – in the example, we append _UTM_46N



d. Select the new CRS you want to project the new layer to
e. Search for the CRS you want, select it and click OK



f. Click ok and the new projected file will be added to the map

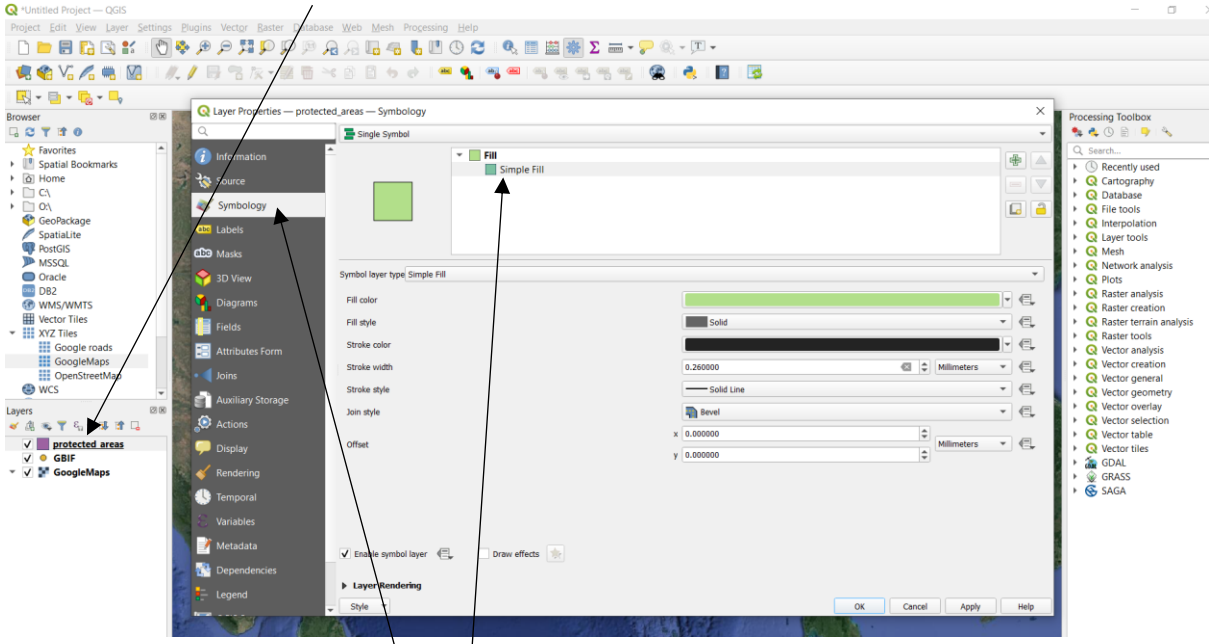
2.3. Saving a QGIS project

a. Click **Project >> Save As** or **Save Project from the main menu**
b. Navigate to a folder to save the project and give it a name
c. Click **Save**

2.4. Symbology

2.4.1 Vector Symbology

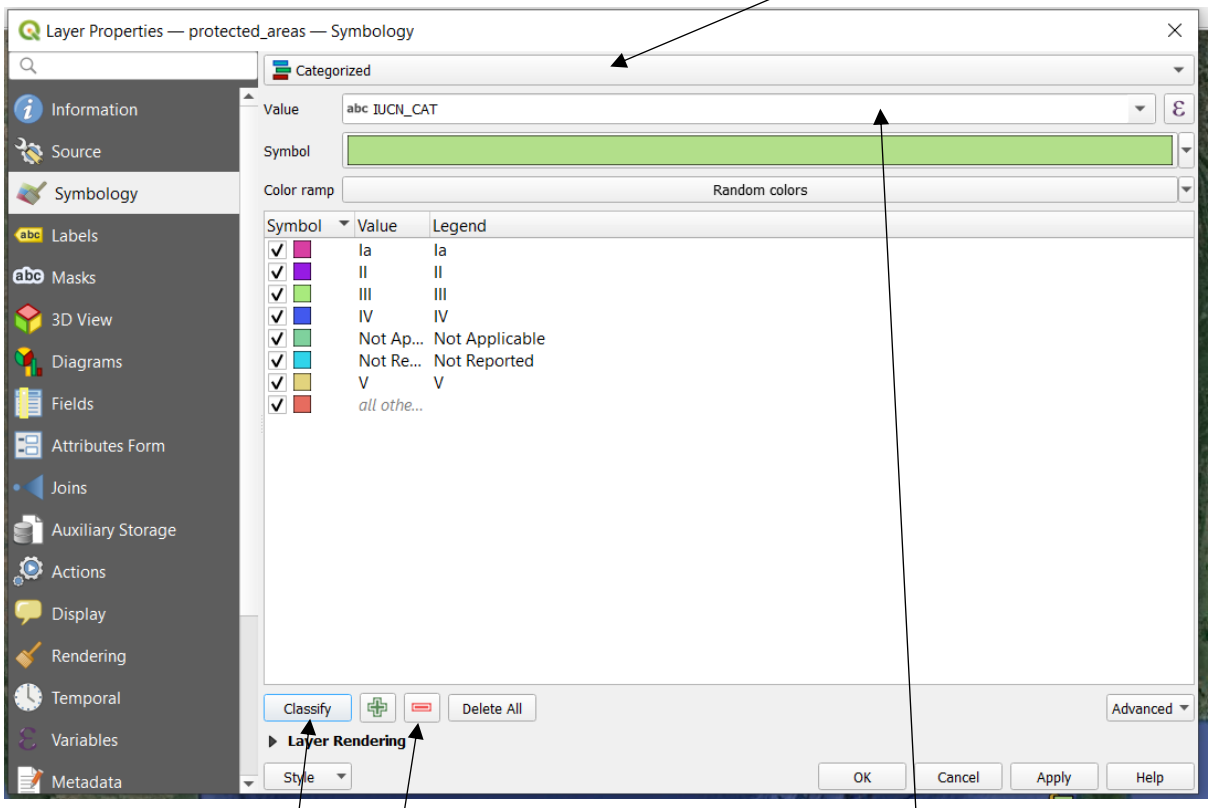
a. When a dataset is added to QGIS it is added with a simple solid fill, random coloured symbology. **Double-click** on the data layer in the Table of Contents to change this.



The **layer properties window** opens

b. Click on the Symbology tab
c. Click the **Simple fill** box to change both the fill and stroke symbology
d. You can change other elements here too, such as fill style and outline (stroke) colour
e. Click OK

g. For categorical data e.g. to shade a layer based on a set of thematic values in the attribute table of a layer, Click the **Single Symbol** to drop down the options. Select **categorized**



h. Choose the attribute of the layer upon which to base the shading. E.g. in this example **'IUCN_cat'**

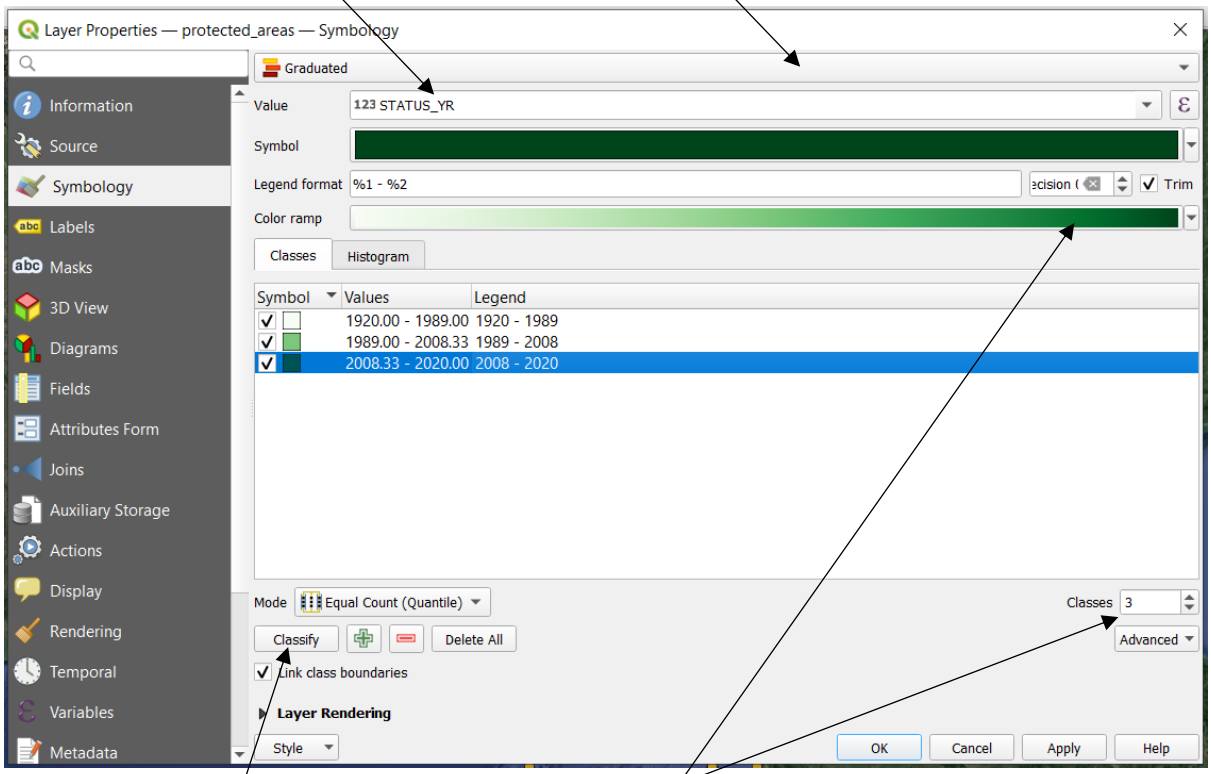
i. Click the **Classify** button to add the unique combinations to the symbol window.

j. To remove any symbols (e.g. the empty one that is always added at the end), click the symbol row, then Click **Delete**

k. **Double-click** on each symbol to bring up the **Symbol Selector Window** and change the symbology for each individual symbol, in the same way as for the **Single Symbol**

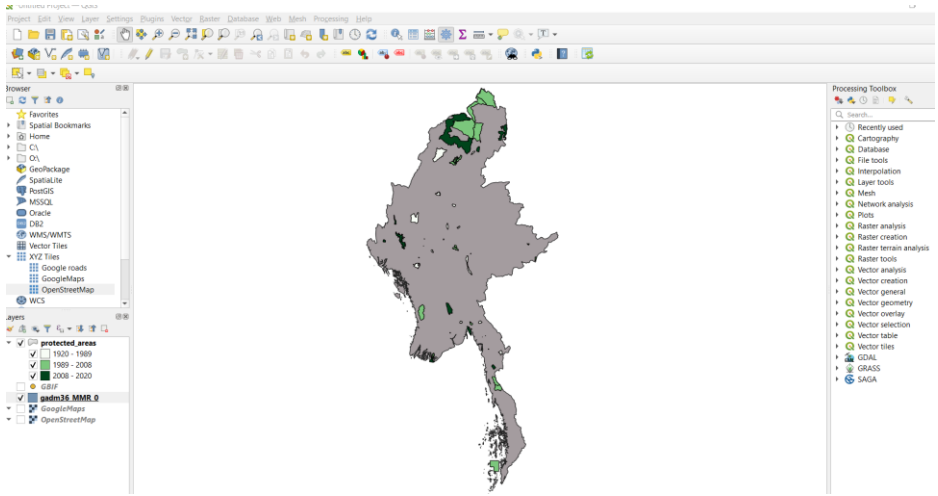
Some data are best presented using a **graduated** symbology

a. **Double-click** on the data layer in the Table of Contents
b. Click **graduated** from the drop-down box
c. Choose the attribute of the layer upon which to base the shading. E.g. in this example **'STATUS_YR'**



d. Choose the number of class breaks
e. Click the **Classify** button to add the unique combinations to the symbol window
f. Chose a colour ramp to shade the data
g. Click **OK**

Example map below

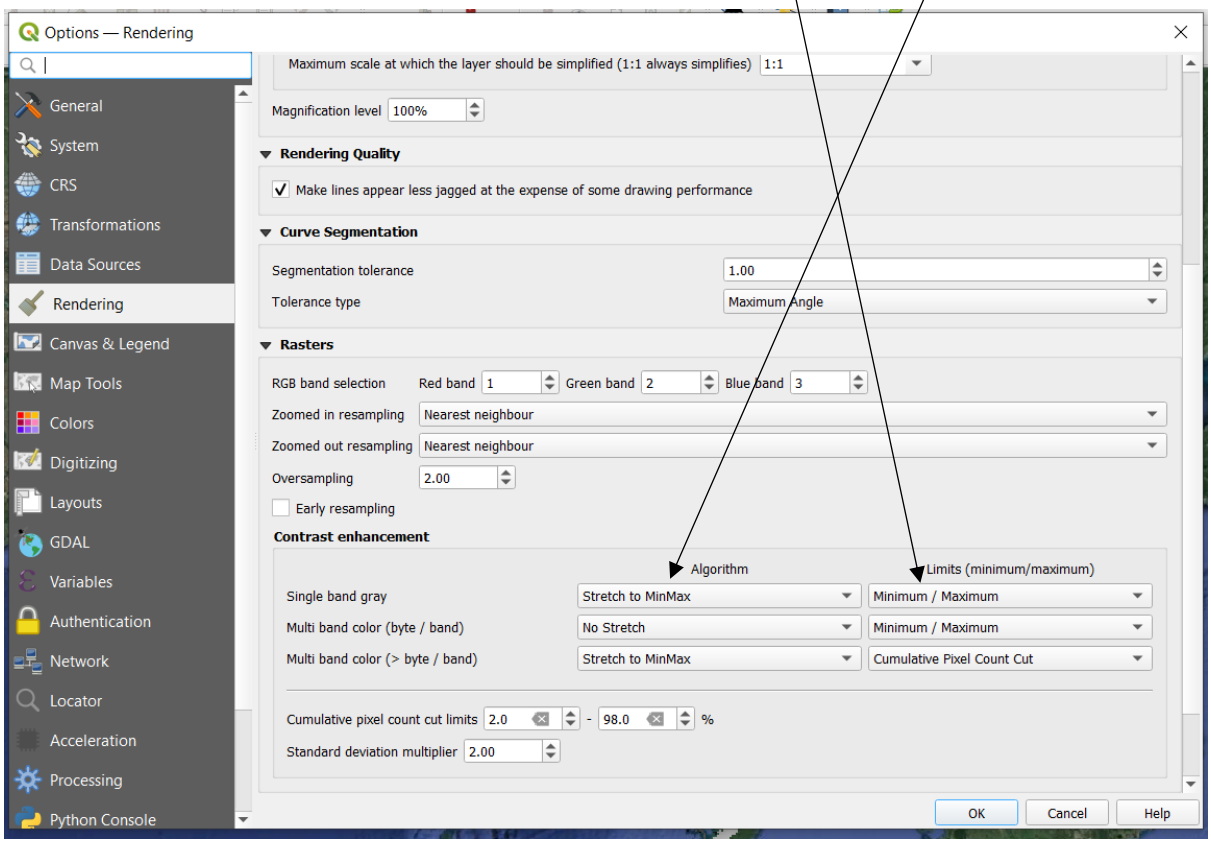


2.4.2 Raster Symbology

Raster symbology can seem a little more complicated than vector symbology. The notes below should help users understand raster symbology a little better.

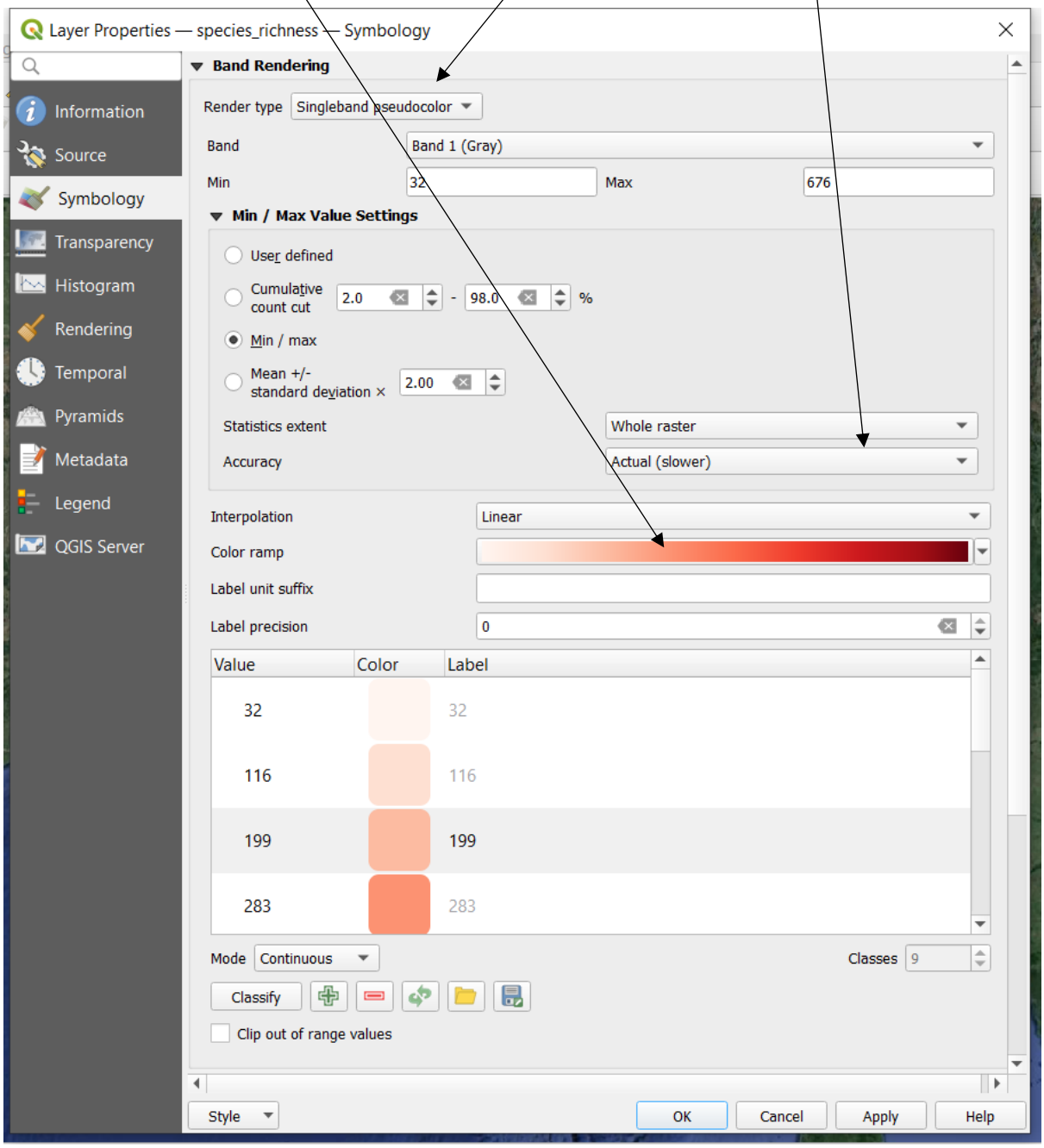
First, **check** to ensure rasters are displaying the full range of values by default:

a. From the main menu, click **Settings>>options**
b. Click on the **Rendering** Tab
c. Scroll down to **Rasters**
d. Ensure the algorithm box for **Single band grey** is set to **Stretch to MinMax**
e. Ensure **Limits (Minimum Maximum)** is set to **Minimum Maximum**
f. Click **OK**



QGIS will automatically show the raster layer in grey colour scheme but you can change this easily.

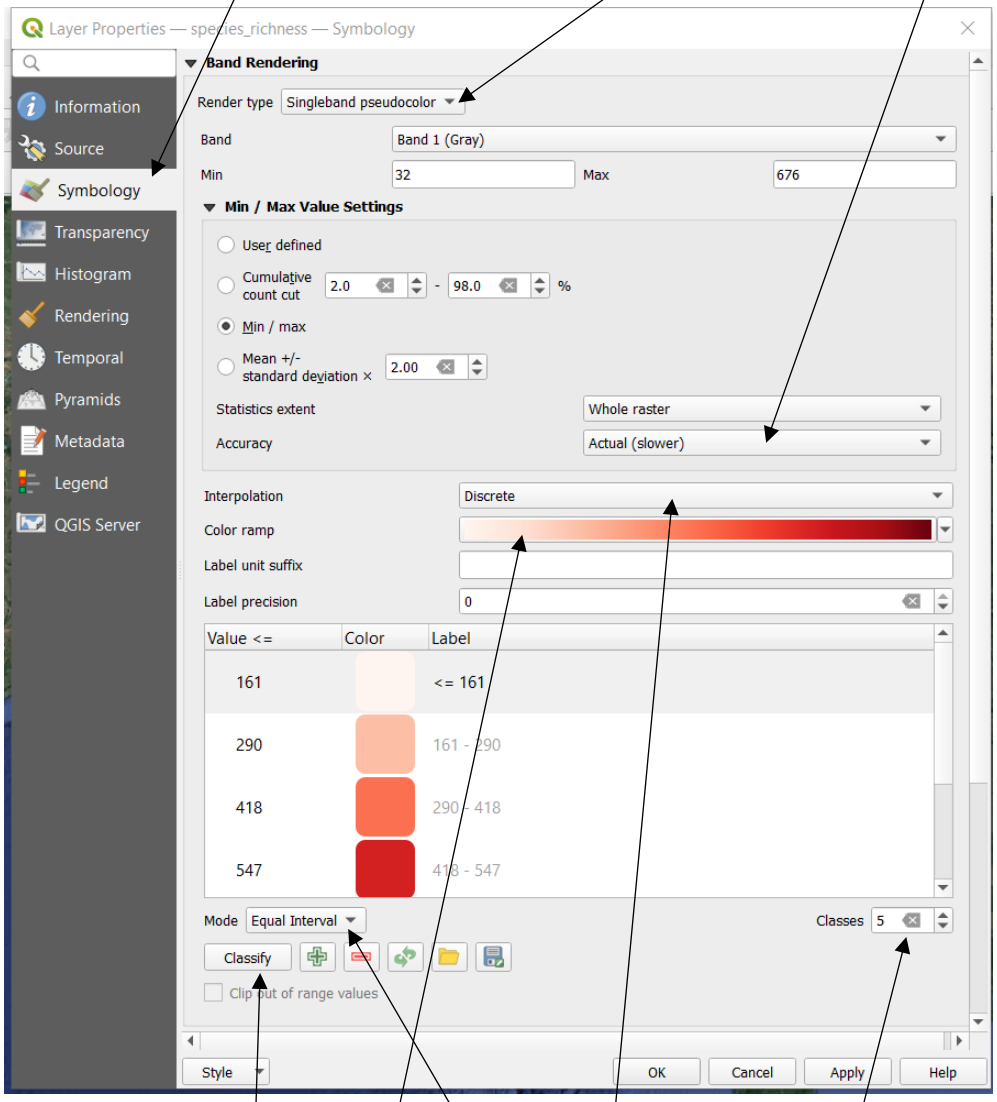
a. **Double-click** on the raster dataset to bring up the **Layer Properties** window
b. Click on the **Symbology** tab
c. Change the **Render type** to **Singleband pseudocolor**
d. Expand the **Min / Max Value Settings** and change the **Accuracy** to **Actual (slower)**
e. Chose the **Color ramp** you would like



f. Click OK

Alternatively you can choose to display the raster dataset in class breaks:

a. **Double-click** on the raster dataset to bring up the **Layer Properties** window
b. Click on the **Symbology** tab
c. Change the Render Type to **Singleband pseudocolor**
d. Expand the **Min / Max Value Settings** and change the **Accuracy** to **Actual (slower)**

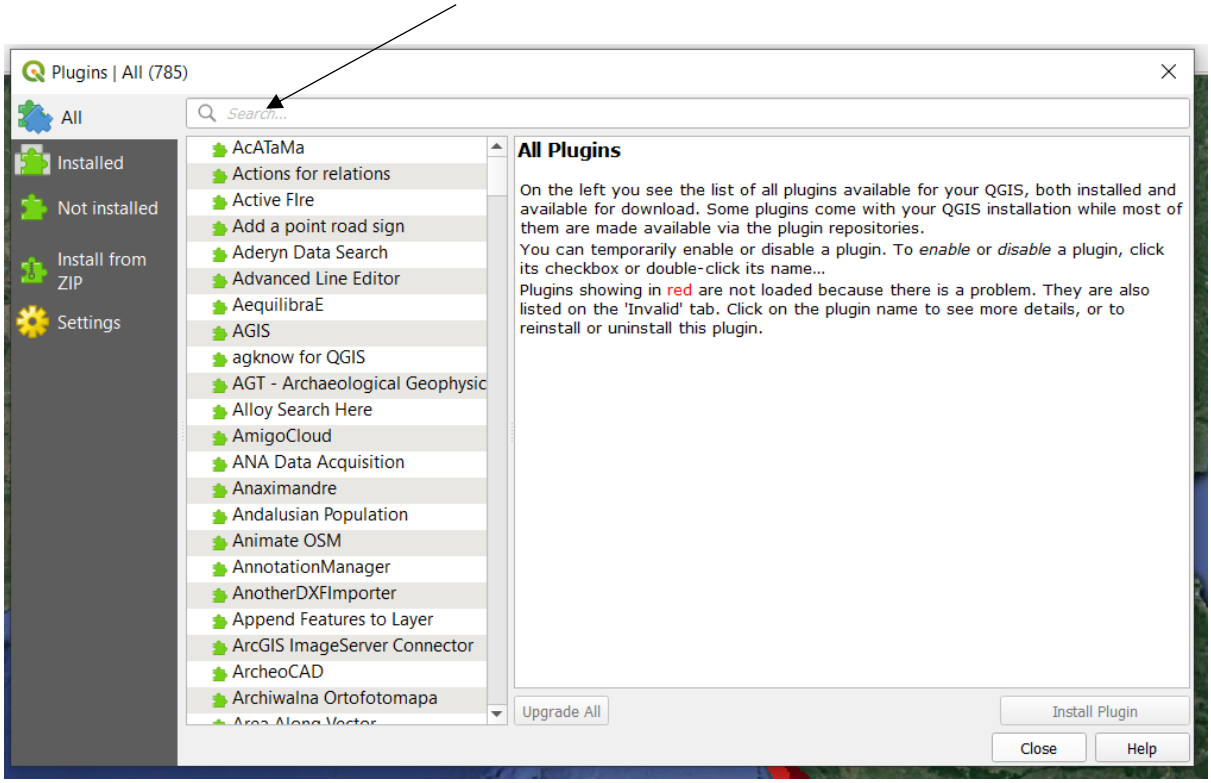


a. **Change the colour ramp**
b. Change the **Mode** to **Equal interval**
c. Change the number of **classes,** in this example we will leave it at **5**
d. Click **Classify**
e. Change the **Color interpolation** to **Discrete** *(choosing discrete means that the colour is discrete for each class rather than Linear which ramps the colour within the classes)*
f. You can manually change the labels if you would like by double clicking on the label value. *You can also manually change the class breaks if you are not happy with the equal interval classes*
g. Click **OK**

2.5. Installing plugins

QGIS comes with an additional functionality in the form of 'plugins'. They are very easy to install, provided there is an internet connection to initially install them. Once installed, they remain in the QGIS installation and an internet connection is not required. Some plugins are part of the core QGIS system and are written in C++ or python. These are part of the QGIS installation and are maintained by the QGIS development team, others are external and maintained by individuals and can be very easily installed manually. This plugin architecture allows many new features and functions to be easily added to the application as they are developed, rather relying on the core development team to add the functionality.

a. From the main menu click **Plugins>>Manage and Install Plugins**
b. Click on the **'All' tab**
c. Search for the desired plugin from the list and click **Install plugin**



2.5.1. Useful plugins for spatial analysis to inform REDD+ planning and safeguards policies

Here are a few plugins that have been particularly useful so far in carrying out spatial analysis work for REDD+ planning:

2.5.1.1. qNote

"qNote" is a great way of storing documentation about a QGIS project. The plugin adds an additional free-text window to the project in which notes can be typed. This provides a method to attach metadata within the project so that it does not get lost. Information on the following could be stored:

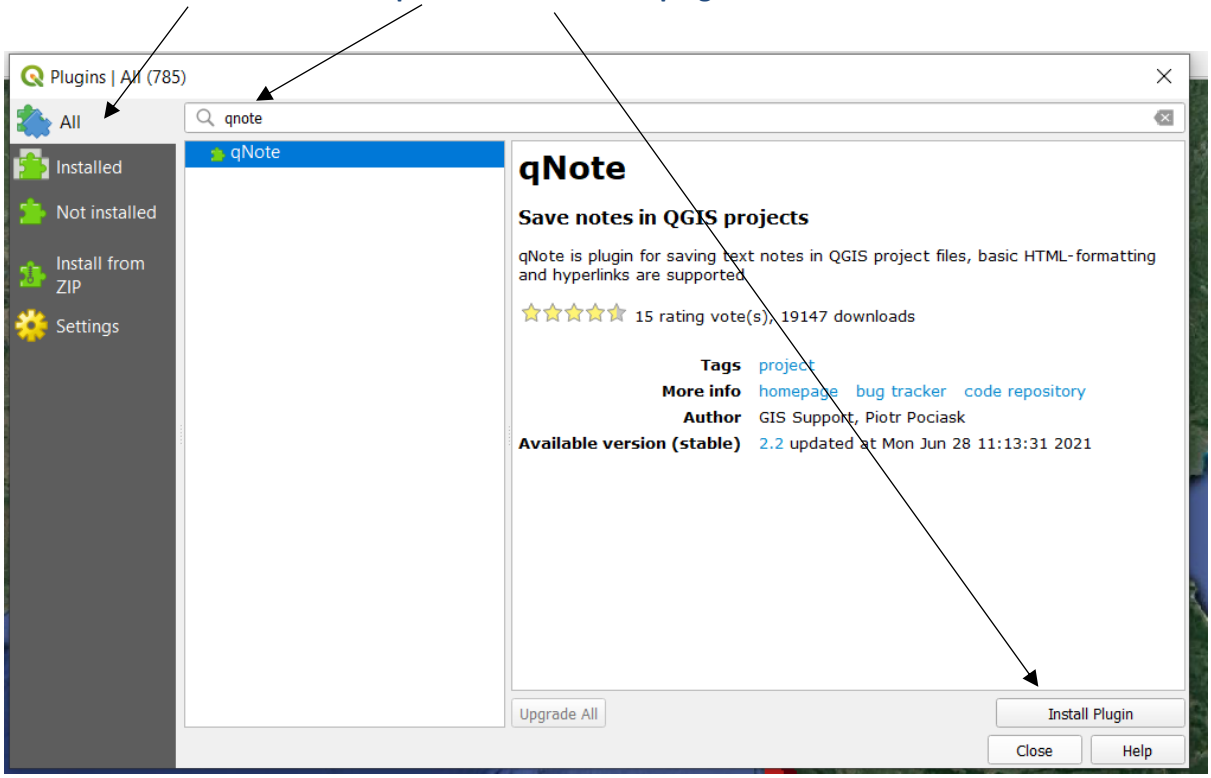
- Content of the project

- Purpose
- Analytical methodologies
- Area of interest
- Where the data came from
- Who created the project
- What the project was created for e.g. a report or publication
- Version of the project / date last edited
- Restrictions on sharing the project

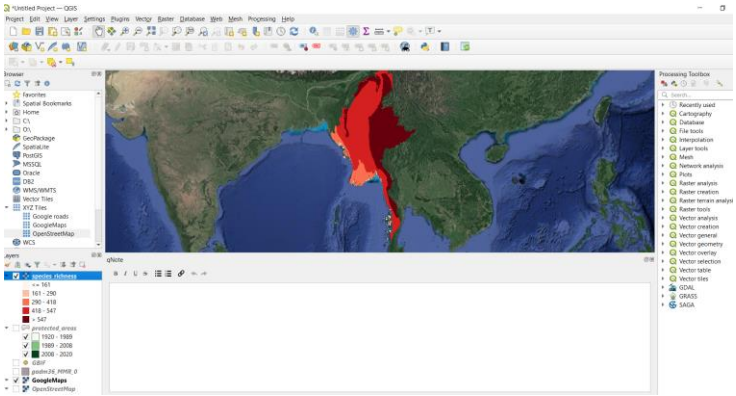
This information stored within a project is extremely valuable when sharing projects as well as providing a reminder when revisiting a project at a later date.

a. Click on **Plugins>>Manage and Install Plugins**

b. In the **All** tab search for **qNote** and click **install plugin**



c. The **qNote** window appears at the bottom of the QGIS project. The window can be turned on and off by clicking **View>>Panels** and selecting **qNote** on or off.

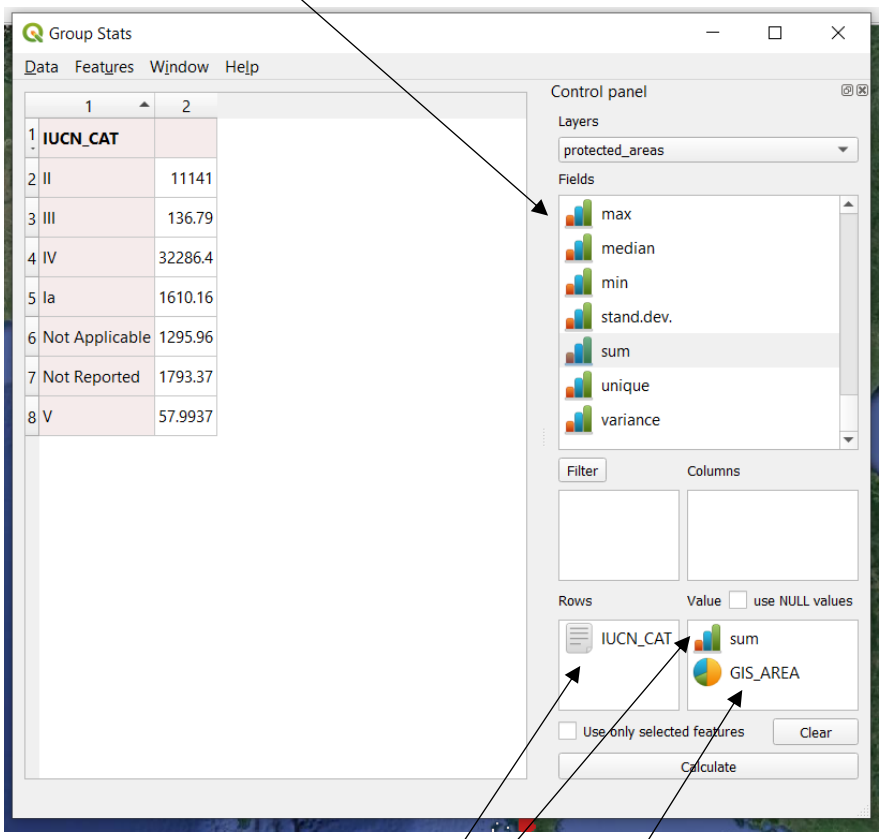


2.5.1.2. Group stats

Simple statistics can be calculated from vector layers using the standard QGIS tools from the **Vector>>Analysis Tools>>Basic statistics for Fields** or **Vector>>Analysis Tools>>List Unique Values** menus. However, these are not sophisticated enough for summarizing the results of overlay analyses.

The Group Stats plugin is useful for creating summary statistics about a dataset based on groups of features. It is similar to a pivot table in Excel.

a. Click on **Plugins>>Manage and install plugins**
b. In the **All** tab, search for Group Stats and install the plugin.
c. Once installed, Group Stats can be accessed from the **Vector>>Group Stats** menu
d. Use the Fields panel to select the fields and functions that you are interested in and drag them down into the Rows, Columns and Value boxes



The above example shows the area of protected areas broken down by IUCN categories

e. Drag a summary field into **Rows**
f. Drag a function into **Value**
g. Drag the value to summarise into **Value**
h. Click **Calculate** to calculate the summary statistics

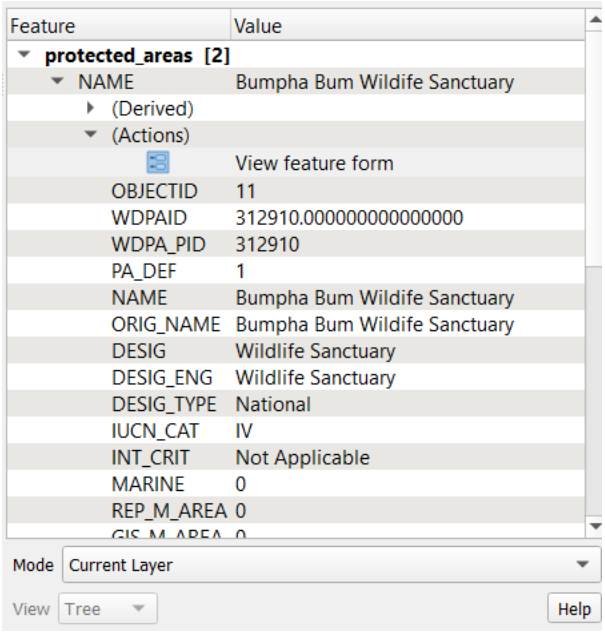
2.6. Querying data

Data can be simply queried in the following 3 steps:

a. First click on the **data layer** in the **Layer Panel** to select the layer to query.

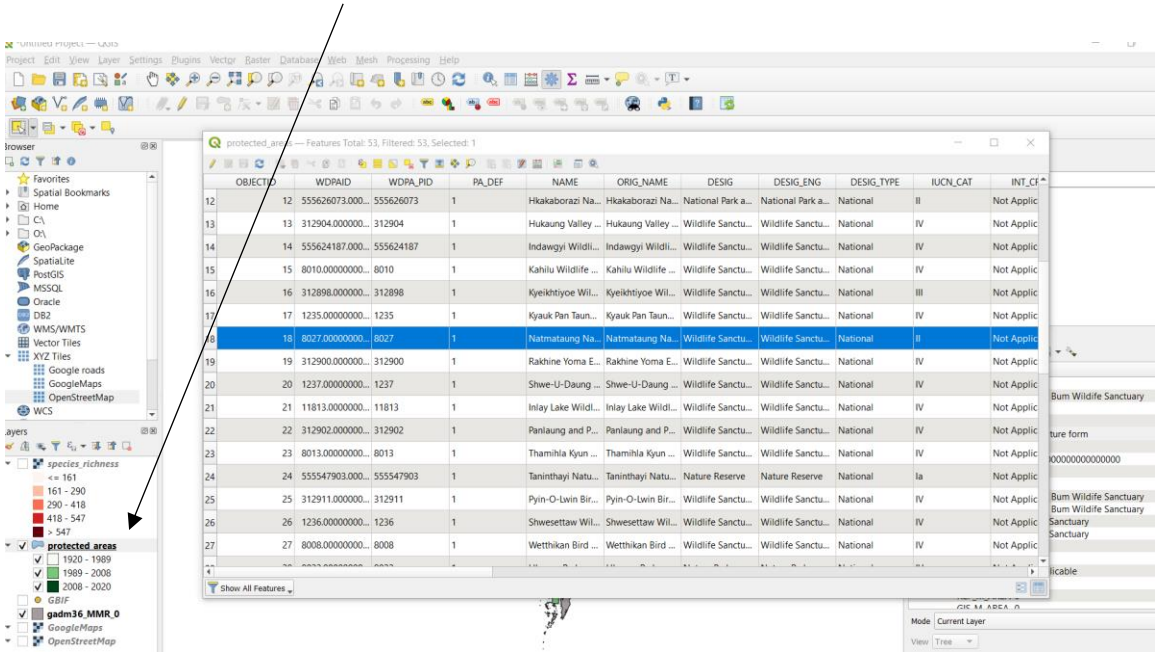
b. Click the  **identify button.**

c. Then click on any **feature of interest** in the **map canvas** to identify the feature within the selected layer.

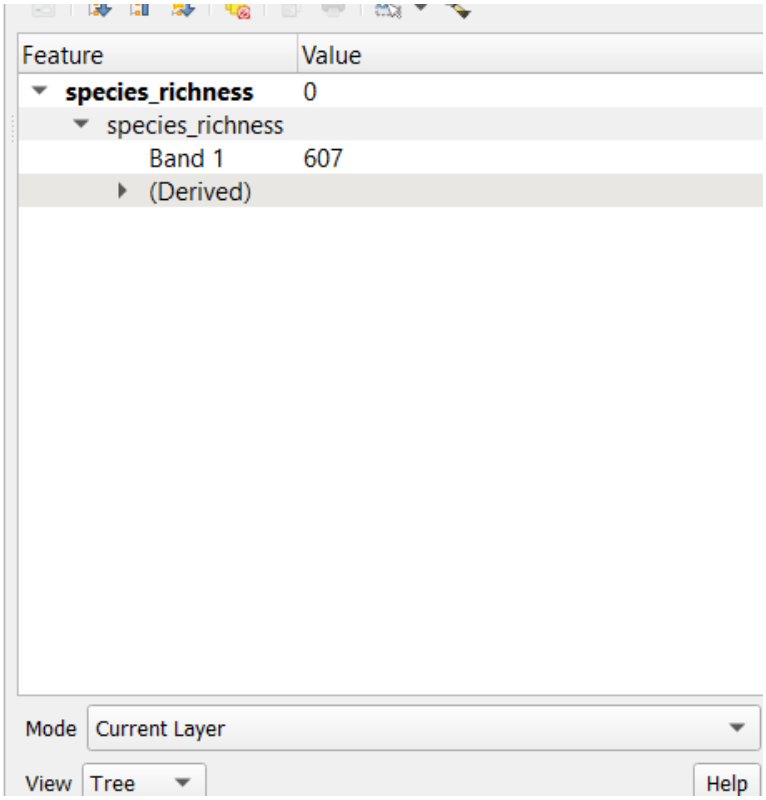


d. Alternatively a feature can be selected by clicking on the **map canvas** with the **select features by area or single click** tool  and the feature(s) is highlighted.

The **attribute table** can then be opened to see the **highlighted selected feature(s).** It can be opened by right clicking on the layer in the Layers panel and selecting **Open attribute table**.



e. For Raster data there is **NO option to open an attribute table**, as QGIS does not recognise them. The only option for rasters is to click on the **raster data layer** in the **TOC** to select the layer to query, and then **click on the map** with the **identify button**  to bring up the **Identify Results window**

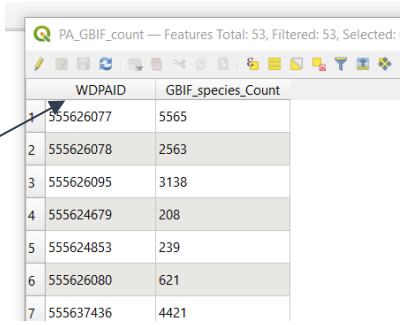


2.7. Joining Tables

a. Joining of Tables is simple in QGIS. First **identify the datasets/tables to join**. Check there is a **common field** that can be used to join the tables together. The names of the join fields do not have to be the same – just have the same content (for example here we join a table PA_GBIF_count.csv to protected_areas.shp).

b. Add the table to be joined to the shapefile to the QGIS project with the **Data Source Manager – Vector** tab

c. Open the attribute tables of the dataset to be joined to explore the fields e.g. in this example a table containing GBIF species records in protected areas that will be joined to a shapefile of a protected areas.



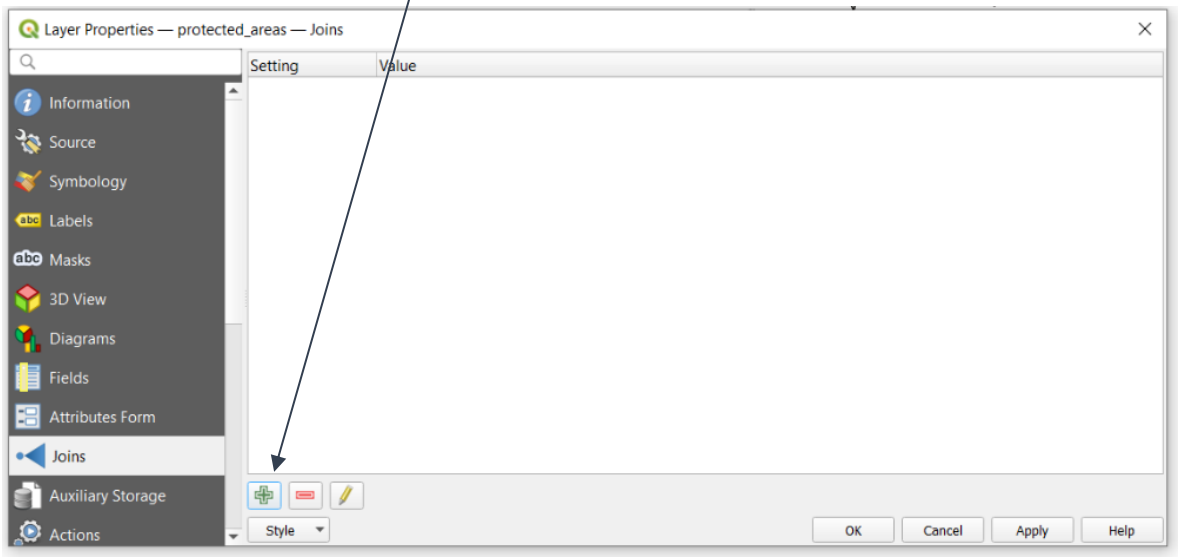
d. Note the names of the field to be used in the join, in this example, the ID of the protected areas is called 'WDPAID'.

e. Close the Attribute table.

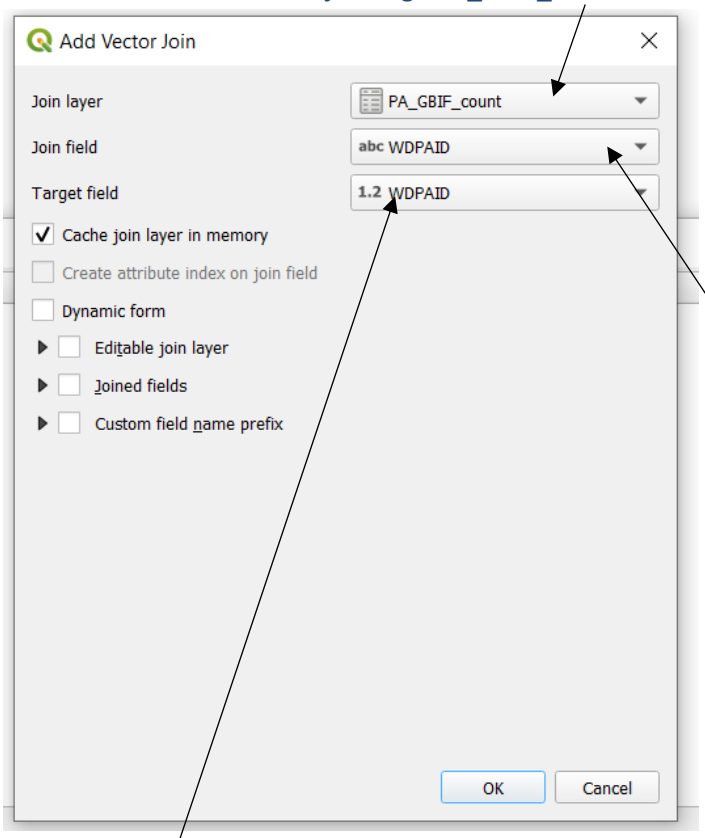
f. **Right-click>>Properties** on the data layer to join to (e.g in this example the protected_areas) or **double click on it**.

g. In the **Layer Properties** window click on the **Joins.**

h. To add a join, click on the **'+' button.**



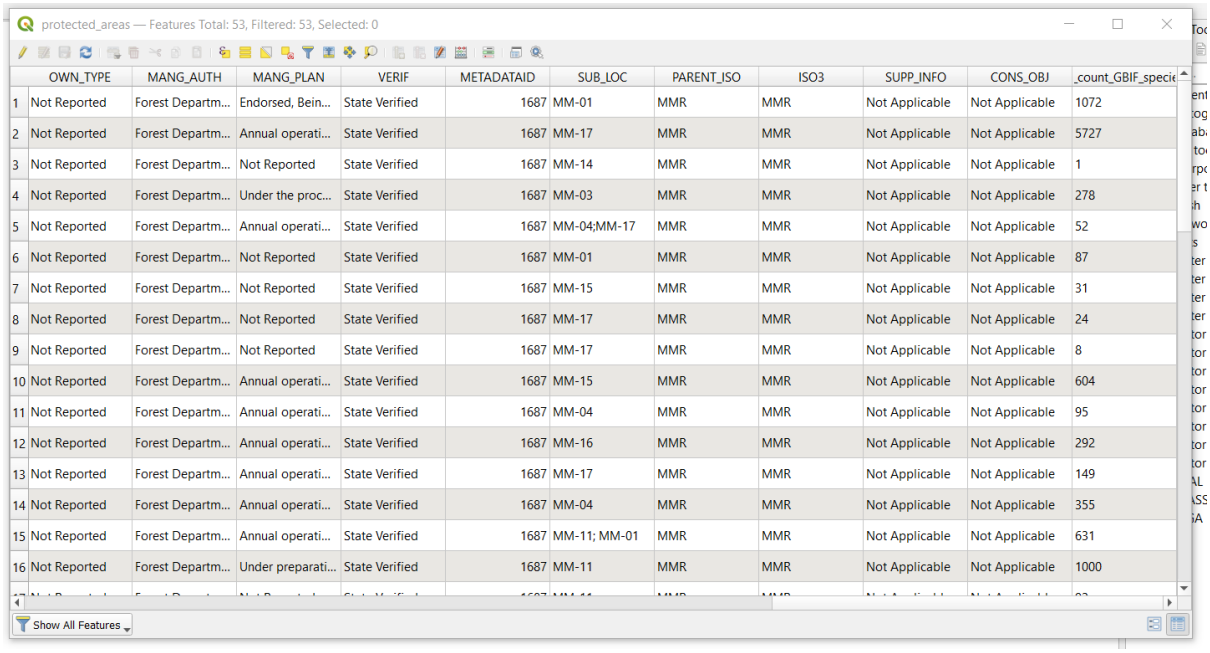
i. Select the **table to join** e.g. PA_GBIF_count



j. Make sure the fields you want to use to join the two tables is selected in the **Join field** and **Target field** boxes. In this example WDPAID

k. Click **OK**.

l. The table has been **temporarily joined** onto the shapefile. If you open the attribute table of the shapefile, you will see the GBIF_Species_count field from, the csv file has been added



	OWN_TYPE	MANG_AUTH	MANG_PLAN	VERIF	METADATAID	SUB_LOC	PARENT_ISO	ISO3	SUPP_INFO	CONS_OBJ	_count_GBIF_specie
1	Not Reported	Forest Departm...	Endorsed, Bein...	State Verified	1687	MM-01	MMR	MMR	Not Applicable	Not Applicable	1072
2	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-17	MMR	MMR	Not Applicable	Not Applicable	5727
3	Not Reported	Forest Departm...	Not Reported	State Verified	1687	MM-14	MMR	MMR	Not Applicable	Not Applicable	1
4	Not Reported	Forest Departm...	Under the proc...	State Verified	1687	MM-03	MMR	MMR	Not Applicable	Not Applicable	278
5	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-04;MM-17	MMR	MMR	Not Applicable	Not Applicable	52
6	Not Reported	Forest Departm...	Not Reported	State Verified	1687	MM-01	MMR	MMR	Not Applicable	Not Applicable	87
7	Not Reported	Forest Departm...	Not Reported	State Verified	1687	MM-15	MMR	MMR	Not Applicable	Not Applicable	31
8	Not Reported	Forest Departm...	Not Reported	State Verified	1687	MM-17	MMR	MMR	Not Applicable	Not Applicable	24
9	Not Reported	Forest Departm...	Not Reported	State Verified	1687	MM-17	MMR	MMR	Not Applicable	Not Applicable	8
10	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-15	MMR	MMR	Not Applicable	Not Applicable	604
11	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-04	MMR	MMR	Not Applicable	Not Applicable	95
12	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-16	MMR	MMR	Not Applicable	Not Applicable	292
13	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-17	MMR	MMR	Not Applicable	Not Applicable	149
14	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-04	MMR	MMR	Not Applicable	Not Applicable	355
15	Not Reported	Forest Departm...	Annual operati...	State Verified	1687	MM-11; MM-01	MMR	MMR	Not Applicable	Not Applicable	631
16	Not Reported	Forest Departm...	Under preparati...	State Verified	1687	MM-11	MMR	MMR	Not Applicable	Not Applicable	1000

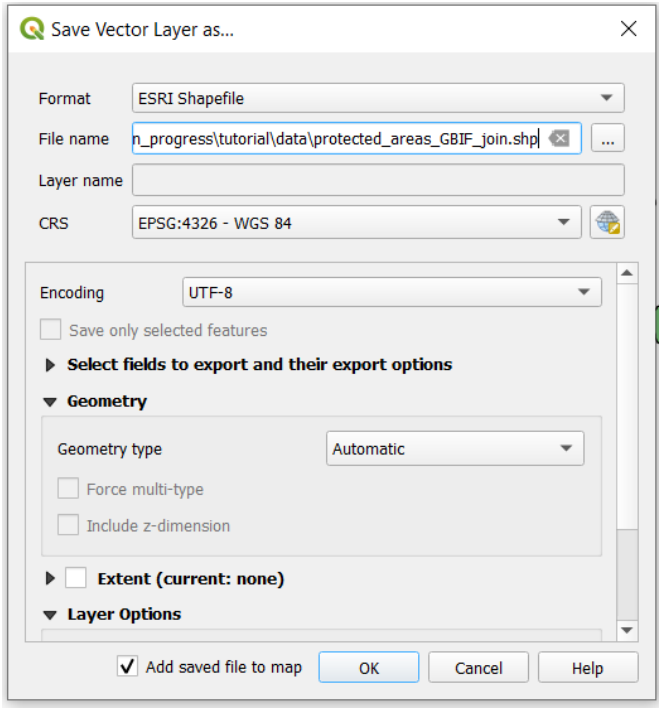
m. To make the join permanent, **Right-click** on the shapefile and click **Export >> Save Features As…**

n. Click **Browse** to save the shapefile with a new name

o. Tick to **Add saved file to map**

p. Click **OK**

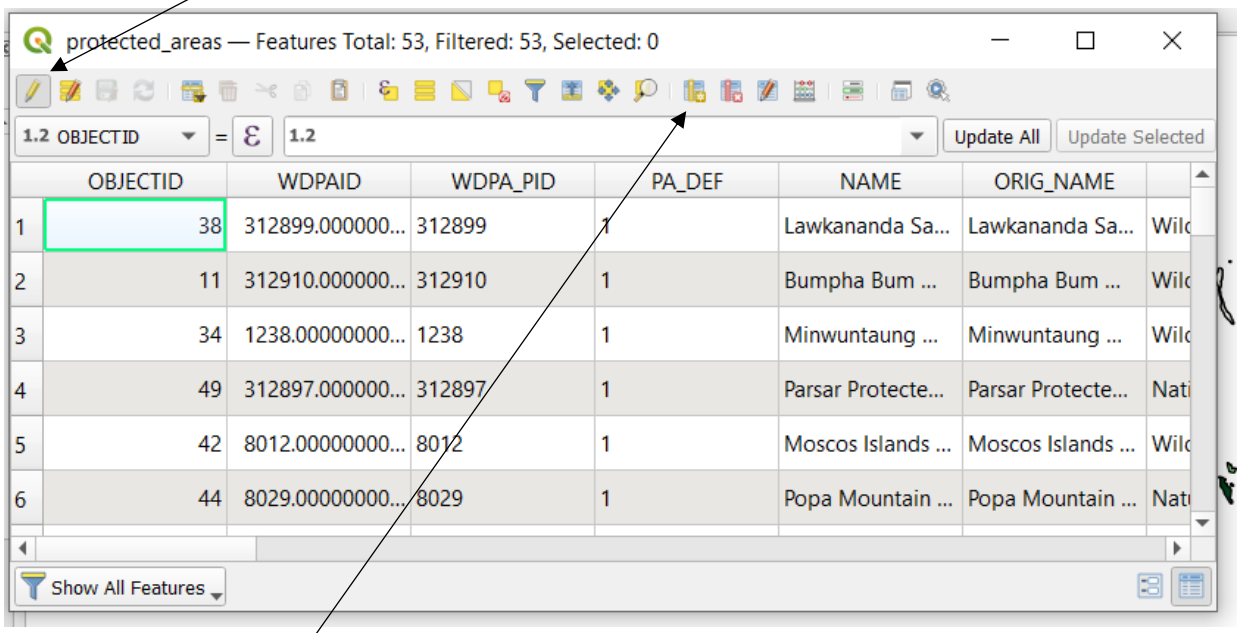
q. The new dataset is added to the map



Note: that all the fields joined from a CSV file will be of type 'string'. Some may need to be numeric but unfortunately the field types cannot be changed. The solution is to add a new field and calculate the information across from the string field to the numeric field, as follows:

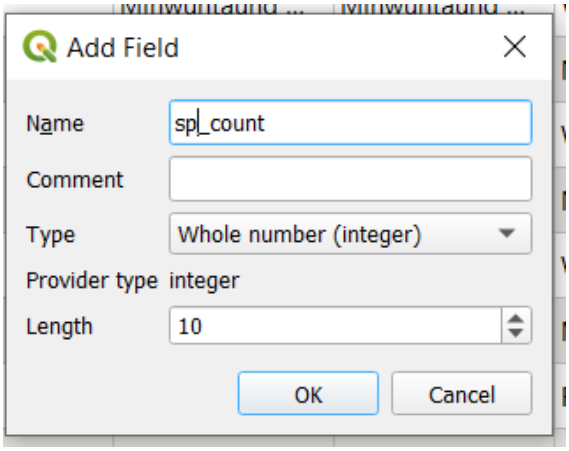
a. Open the attribute table

b. Click the  **toggle editing** button to start editing



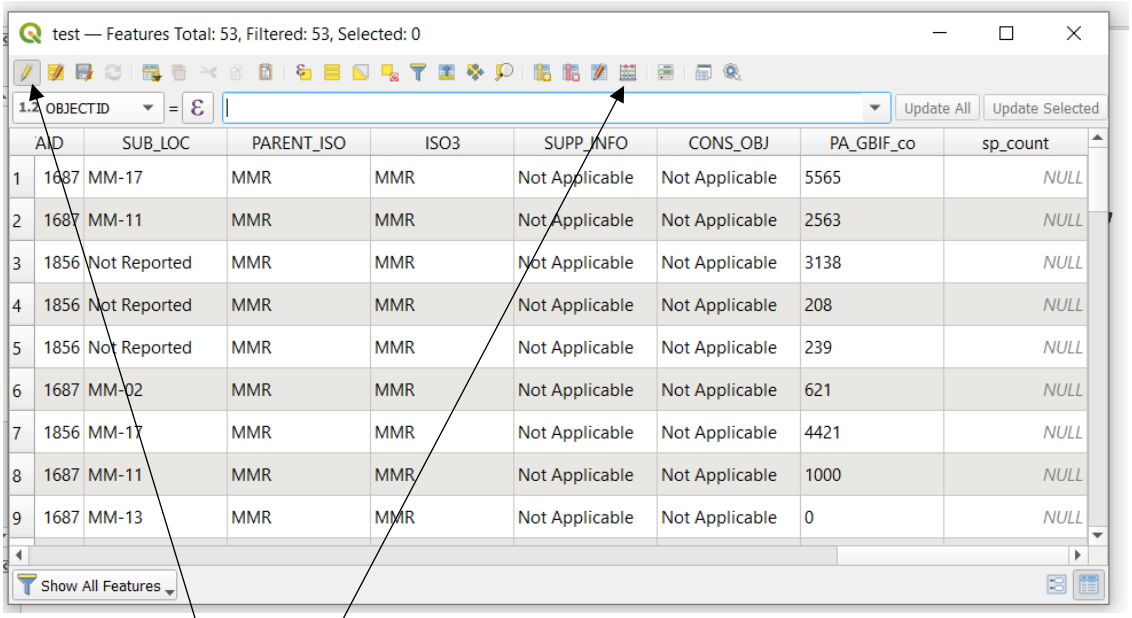
c. Click the **Add Field** Button

d. Give the field a name, e.g. ‘sp_count’
e. Set the **Type** to **Whole number (integer)**
f. Click **OK**



g. Click the  **toggle editing** button again in the attribute table to stop editing
h. Click **Save**

i. **Right-click** on the data layer and **open the attribute table**. The new ‘empty’ field is located at the end of the table.



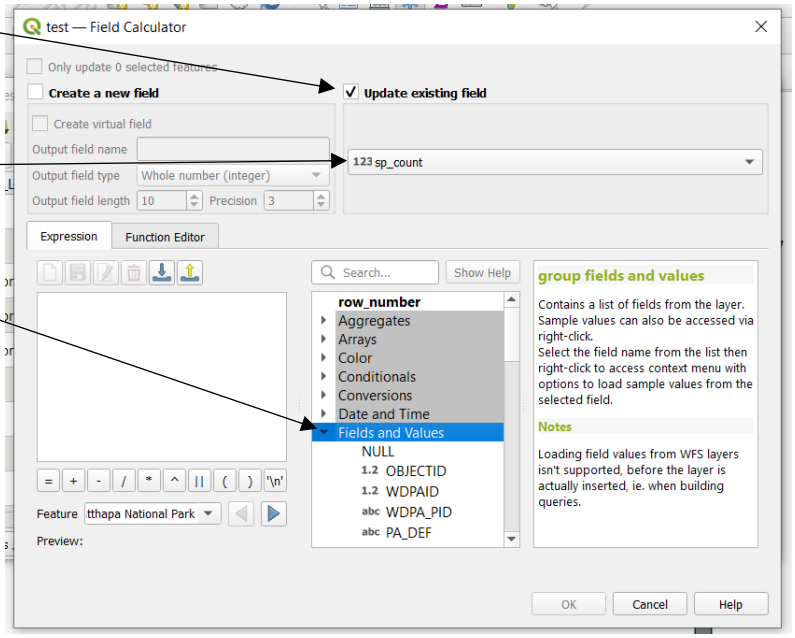
	AID	SUB_LOC	PARENT_ISO	ISO3	SUPP_INFO	CONS_OBJ	PA_GBIF_co	sp_count
1	1687	MM-17	MMR	MMR	Not Applicable	Not Applicable	5565	NULL
2	1687	MM-11	MMR	MMR	Not Applicable	Not Applicable	2563	NULL
3	1856	Not Reported	MMR	MMR	Not Applicable	Not Applicable	3138	NULL
4	1856	Not Reported	MMR	MMR	Not Applicable	Not Applicable	208	NULL
5	1856	Not Reported	MMR	MMR	Not Applicable	Not Applicable	239	NULL
6	1687	MM-02	MMR	MMR	Not Applicable	Not Applicable	621	NULL
7	1856	MM-17	MMR	MMR	Not Applicable	Not Applicable	4421	NULL
8	1687	MM-11	MMR	MMR	Not Applicable	Not Applicable	1000	NULL
9	1687	MM-13	MMR	MMR	Not Applicable	Not Applicable	0	NULL

j. Click the  **toggle editing** button to start editing.
k. Click the  **field calculator** button

l. In the **Field calculator** tick the **Update existing field**

m. Choose to update the new empty field created (sp_count)

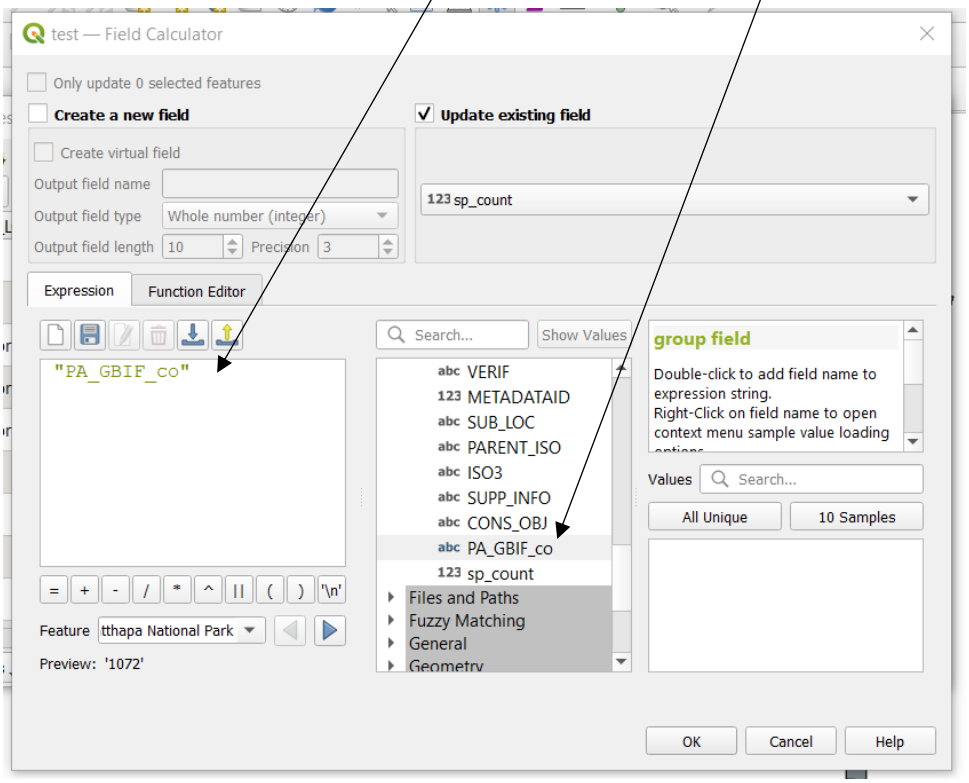
n. Expand the **Fields and Values** section



o. Double-click on the **field** which contains the **data to transfer** to the new field

p. This will bring it into the **expression** window

q. Click **OK**



r. Click the  **toggle editing** button on the attribute table to stop editing

s. Check that the attribute has been updated. It is sometimes necessary to close and reopen the attribute table.

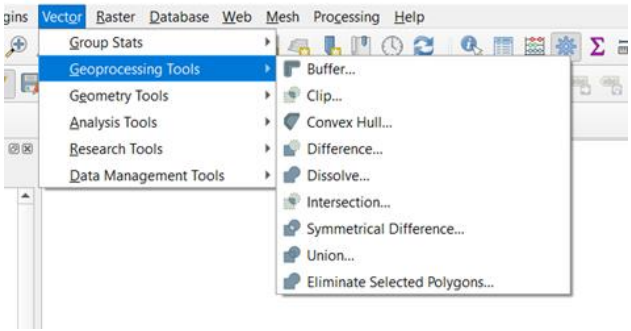
2.8. The Processing Toolbox

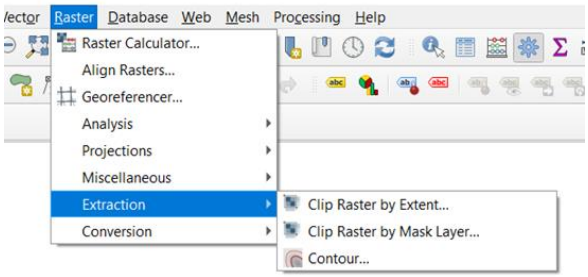
This part of the tutorial makes a brief introduction to the processing toolbox and explains how to access the various analysis tools. It does not go into detail about running the wealth of individual tools available but provides a few examples.

There are four core elements of the processing environment that you should be aware of:

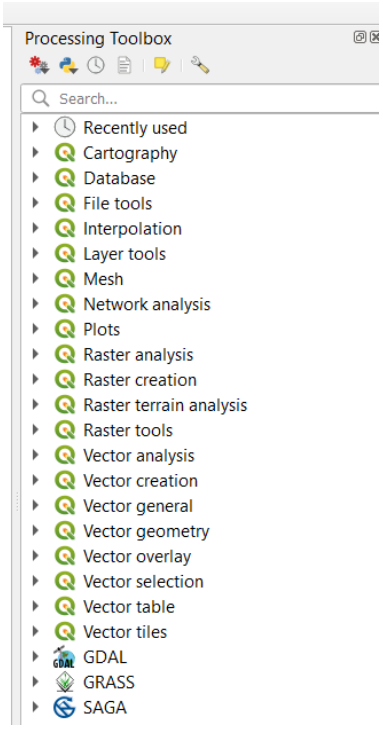
1. The toolbox – the main element where you can access the algorithms and scripts (including ones you have generated yourself).
2. The graphical modeller – where you can generate your own workflows by stringing together a series of algorithms.
3. The history manager – which provides a record of the processes that you have run.
4. The batch processing interface – which allows any of the algorithms to be run in batch mode to process multiple files.

Some of the vector and raster analysis functions can be accessed from the main menu bar, by clicking on **Vector >> Geoprocessing Tools** or by clicking on **Vector >> Analysis Tools.**





NOTE: If the Processing Toolbox doesn't appear on the right hand side of the QGIS window, right-click on the grey bars at the top of the window to activate the Processing Toolbox and make it appear.



There are also further functions in the processing toolbox (access in the right hand panel in the QGIS window) which are **grouped by 'algorithm provider'**. You can search for functions in the **Search** box at the top of the toolbox.

There are two ways to execute an algorithm:

1) Double-click on its name in the toolbox.
2) For batch processing right-click on its name and click **Execute as batch process.**

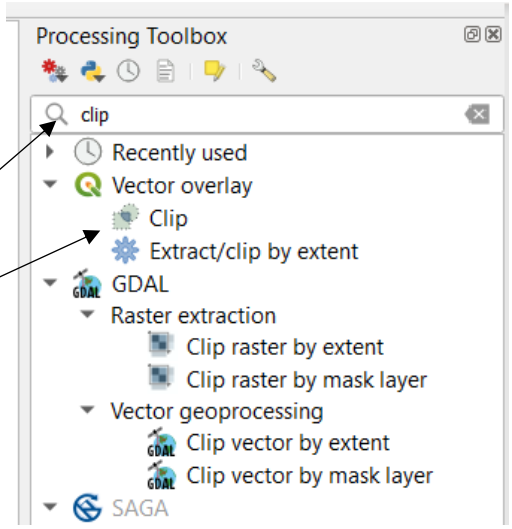
2.8.1. Example 1 – Running a vector clip

The **Vector Clip** tool allows you to cut datasets to a desired area of study.

a. Add the **GMW_2016_V2_MMR** layer to the QGIS project. This is data from Global Mangrove Watch, showing the distribution of mangroves in Myanmar.

b. In the Processing Toolbox, search for **Clip**

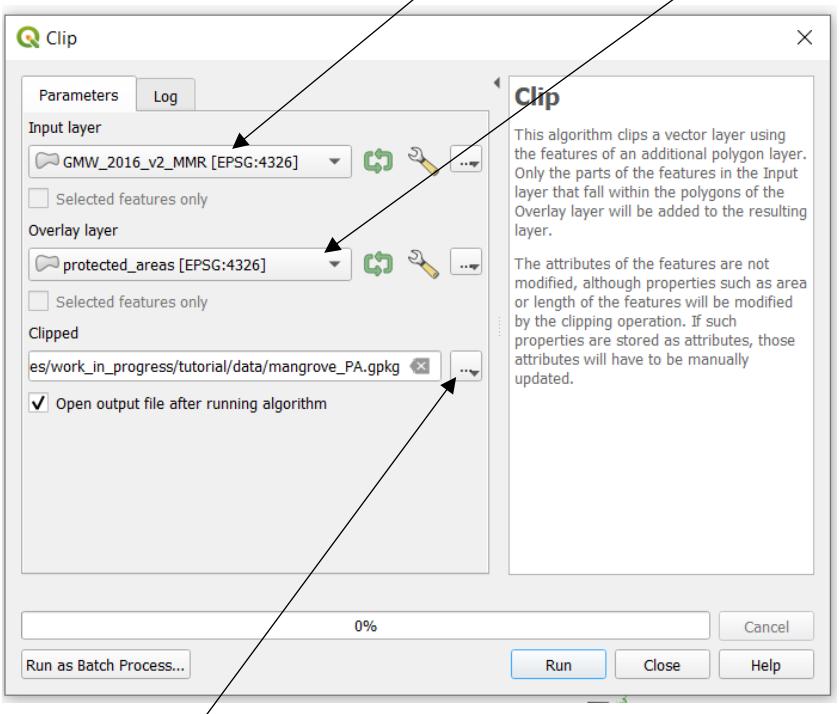
c. Double click on **Clip** under **Vector overlay**



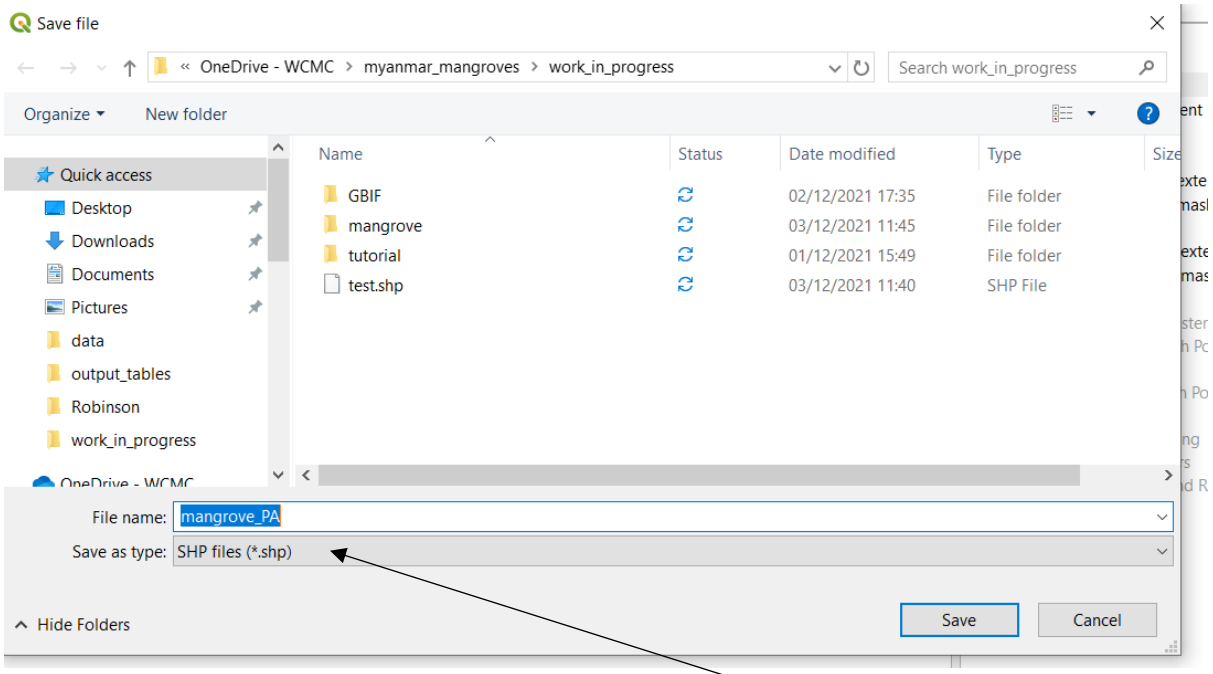
We are going to clip the mangrove by the protected areas to identify the areas of mangrove that fall within protected areas.

d. In the **Input layer** column, select **GMW_2016_V2_MMR**

e. In the **Overlay layer** column, select **protected_areas**



f. Browse (select save to file) to where you want to save the data



g. Give it an appropriate name and change the **Save as type** to **SHP files**

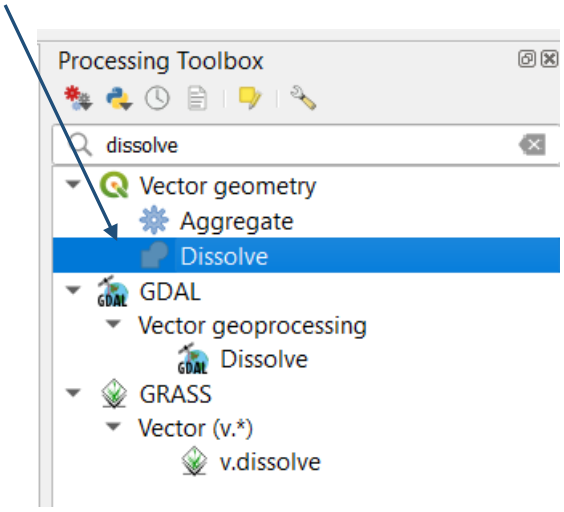
h. Click **Save** and then **Run**

2.8.2. Example 2 – Dissolve

There are various tools that can be accessed from the Advanced Interface which allow you to conduct a 'dissolve' analysis. This provides a good example to show that there are often many tools in QGIS that can run the same or similar analysis. In this example we will run the dissolve 3 times using 3 different tools as there are some slight differences in the results which is worth noting.

a. Search for **dissolve** in the processing toolbox

b. First run the **standard QGIS dissolve**. Double-Click on the QGIS dissolve tool.

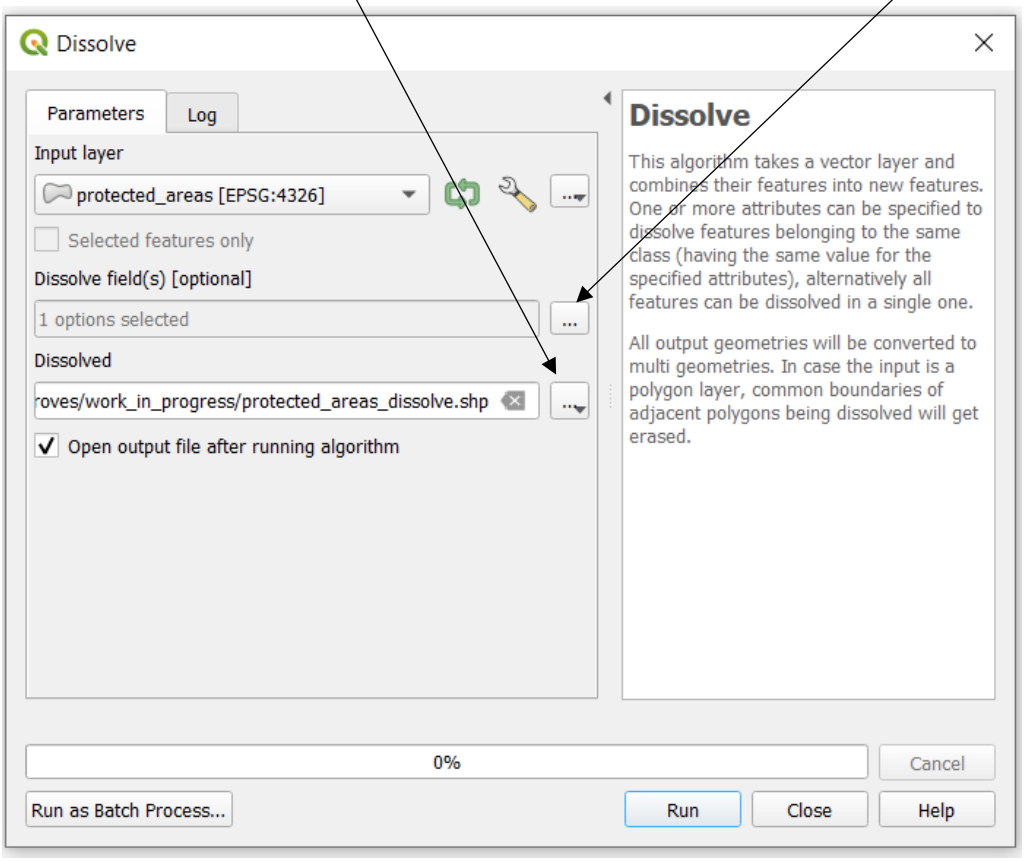


c. Select an **input** file e.g. **Protected Areas** vector layer

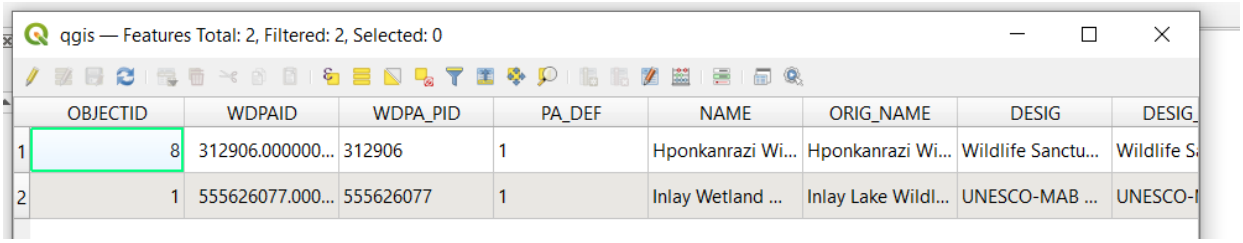
d. Chose a field to dissolve by e.g. **DESIG_TYPE** by clicking on the three dots and ticking the field you want

e. Navigate to an output folder and give the output file a name.

f. Click **Run**

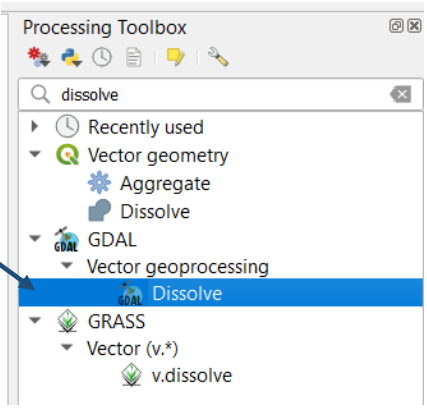


g. On the new dissolved dataset **Right-click>> Open attribute table.** Notice that there is only two rows in the attribute table.

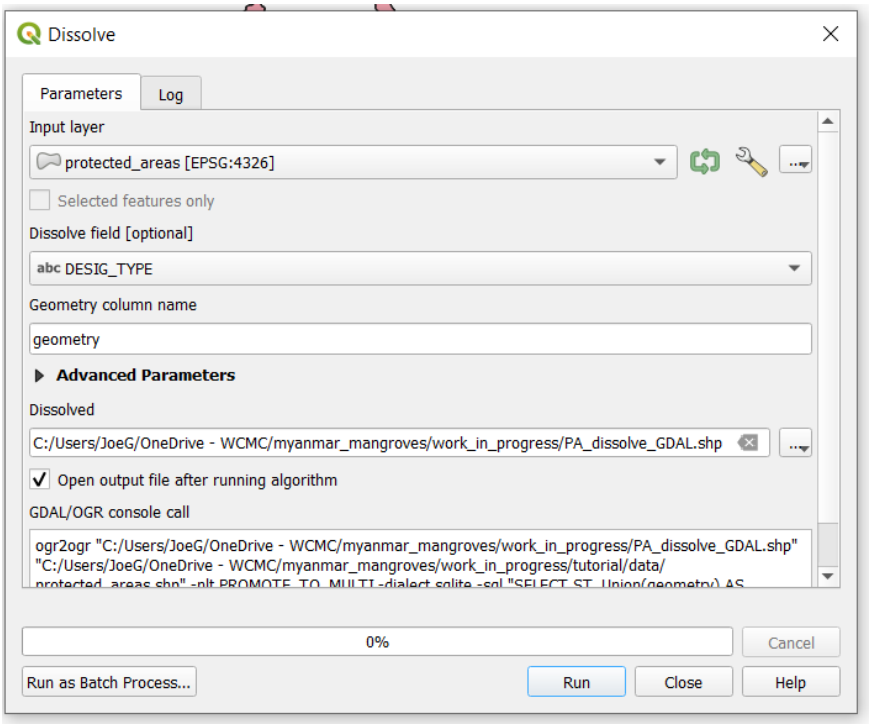


*It has created a **multipart polygon** layer (one attribute to many polygons). Also notice that even though we did a dissolve it has not dropped the attributes fields beyond DESIG_TYPE therefore the rest of the attributes are incorrect, it has just randomly kept the attributes from one of the original polygons.*

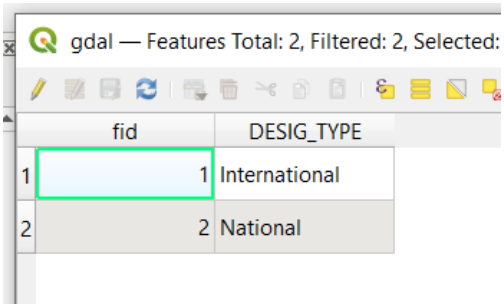
h. Next try the **GDAL** tool **Dissolve**. Use the same file used for the QGIS dissolve tool.



i. Set the **Input layer** (to be dissolved) e.g. Protected Areas.
j. Set the **dissolve field** to DESIG_TYPE.
k. Navigate to an output folder and give the output file a name.
l. Click **Run**

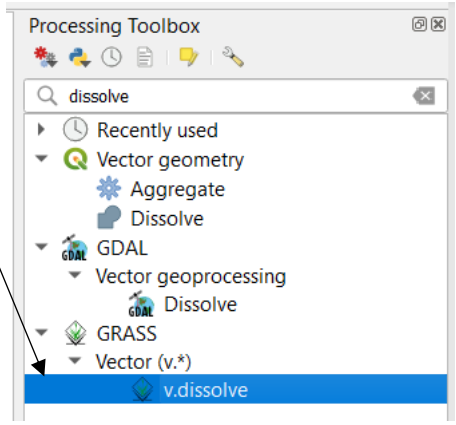


m. On the new dissolved dataset **Right-click>> Open attribute table.** There is again only two rows in the attribute table.

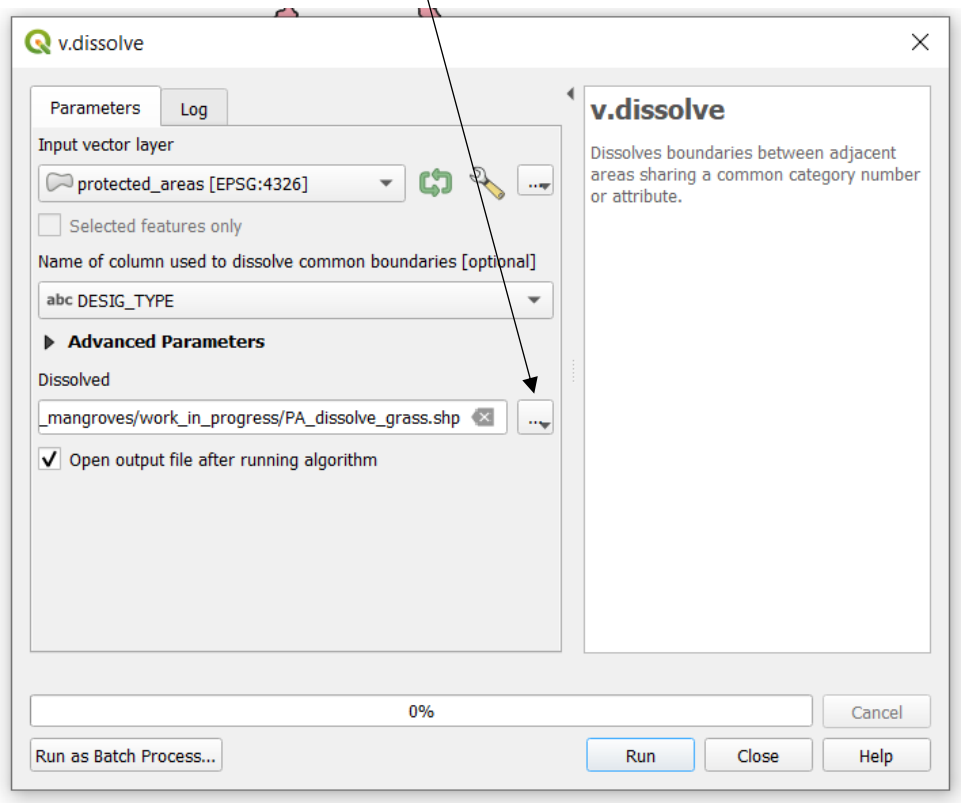


It has created a multipart polygon (one attribute to many polygons). Also notice that it has correctly dropped the other attributes fields beyond the field that was used for the dissolve i.e. DESIG_TYPE.

n. Next try the GRASS tool **v.dissolve.** Use the same files used for the QGIS and SAGA dissolves.

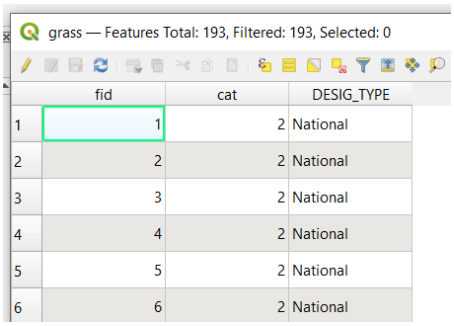


o. Set the **Input Vector layer,** e.g. Protected Areas.
p. Set the **Name of column used to dissolve common boundaries** to DESIG_TYPE.
q. For **Dissolved,** navigate to an output folder and give the output file a name.



r. Click **Run**
s. On the new dissolved dataset **Right-click>> Open attribute table.**

Notice it has many rows. It has create a ***singlepart polygon*** *(one attribute to one polygon). Also notice that it has correctly dropped the other attributes fields beyond DESIG_TYPE.*



This highlights that the GDAL and GRASS dissolve tools work better than the core QGIS one. Both are

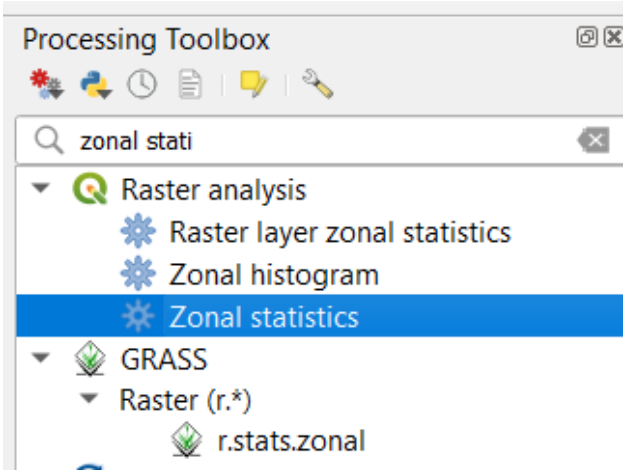
correct but just use different ways of storing the attributes. There is a tool in the QGIS toolbox to convert from multipart to singlepart and vice versa.

Note: If you are running a spatial analysis where one or more of the datasets have multipart features it can sometimes slow down the processing and sometimes cause the process to fail if the multipart features are complex.

2.8.3. Example 3 – Zonal statistics for Raster data

The Zonal statistics algorithm produces statistics for raster layers based on a zonal polygon layer. For example, you can generate statistics of species richness (raster layer) within protected areas (vector polygon zones layer).

a. Search for and double-click on the **Zonal Statistics** tool in the processing Toolbox on the right-hand side of the screen.



b. Choose a **vector polygon** layer to use as the zones to generate the statistics by. E.g. **protected areas**

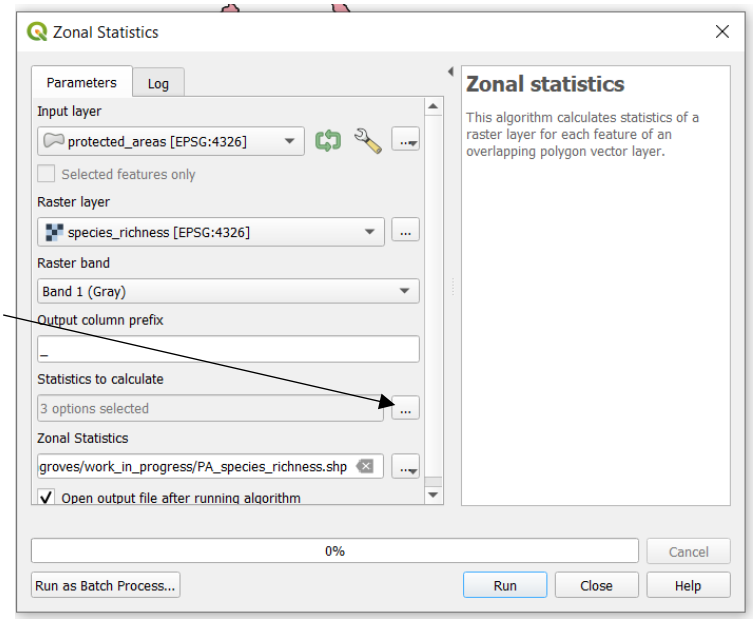
c. Choose a **raster layer** for which to generate statistics e.g. **species_richness**

d. Select the statistics you want to calculate

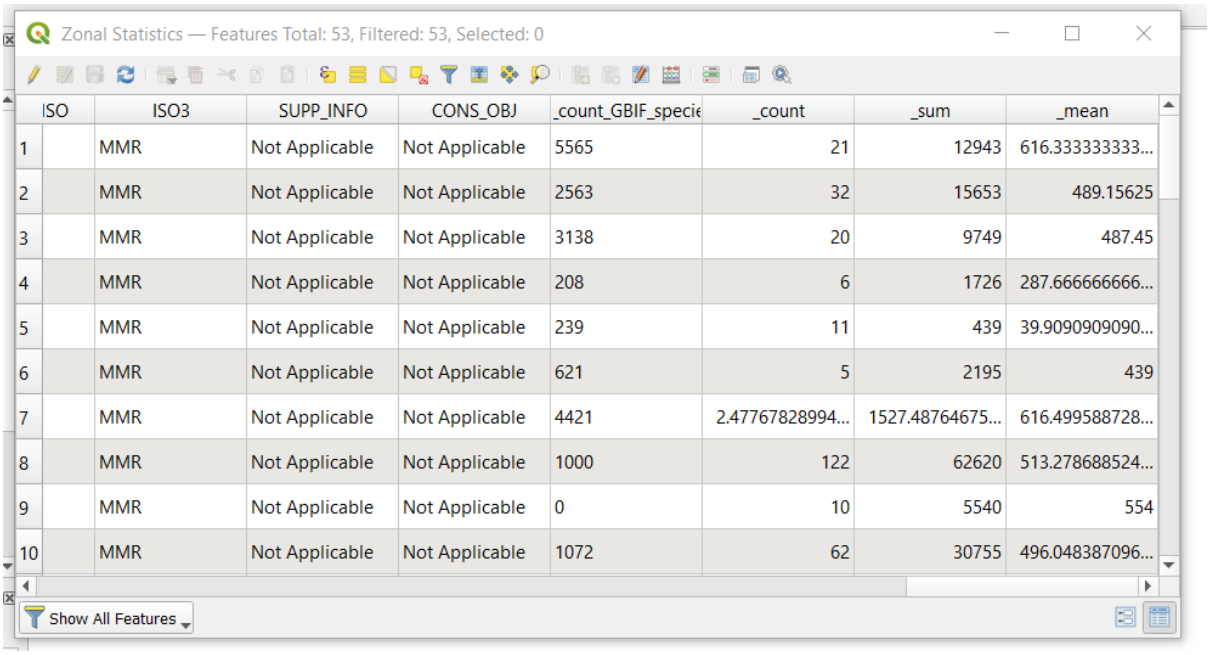
e. Chose an output folder and name for the **new output dataset**

f. Click **Run**

g. Right-click on the new vector layer and **open the attribute table**



The new layer is a copy of the protected areas layer with additional fields **(e.g. _count, _sum, _mean)** containing statistical summaries relating to the raster layer within each protected area polygon .e.g. sum = the sum of the pixels within the protected areas.

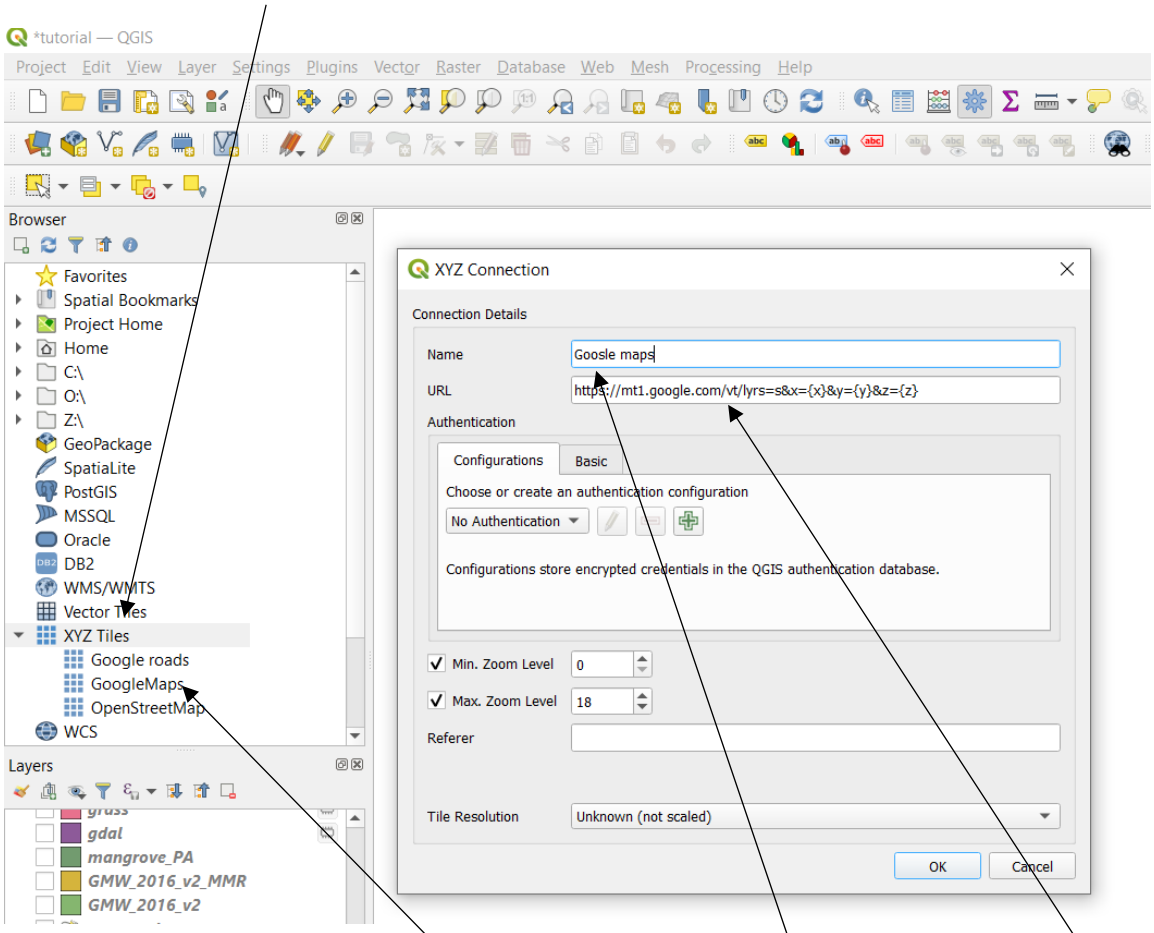


	ISO	ISO3	SUPP_INFO	CONS_OBJ	_count_GBIF_specie	_count	_sum	_mean
1		MMR	Not Applicable	Not Applicable	5565	21	12943	616.333333333...
2		MMR	Not Applicable	Not Applicable	2563	32	15653	489.15625
3		MMR	Not Applicable	Not Applicable	3138	20	9749	487.45
4		MMR	Not Applicable	Not Applicable	208	6	1726	287.666666666...
5		MMR	Not Applicable	Not Applicable	239	11	439	39.9090909090...
6		MMR	Not Applicable	Not Applicable	621	5	2195	439
7		MMR	Not Applicable	Not Applicable	4421	2.47767828994...	1527.48764675...	616.499588728...
8		MMR	Not Applicable	Not Applicable	1000	122	62620	513.278688524...
9		MMR	Not Applicable	Not Applicable	0	10	5540	554
10		MMR	Not Applicable	Not Applicable	1072	62	30755	496.048387096...

2.9. Adding basemaps

It is sometimes useful to have a basemap on you QGIS project so you can see where in the world your data is. This allows you to check your data is displaying in the correct location. You need an internet connection for this.

a. In the **Browser** window, right click on **XYZ Tiles**

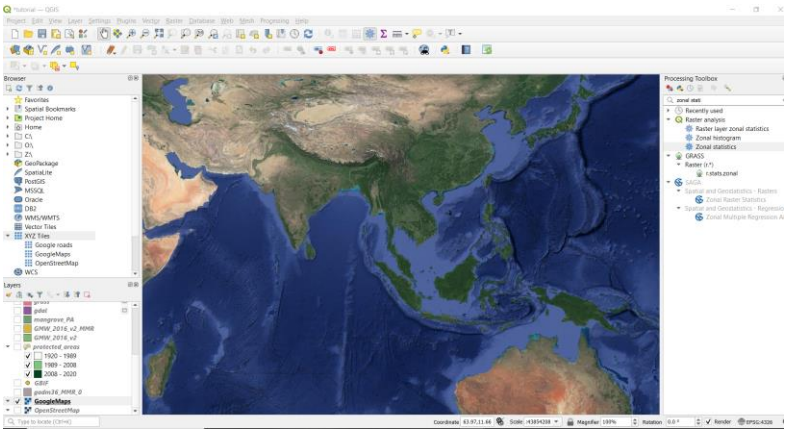


b. We are going to add a Google Maps basemap. In the name box type in Google maps

c. Paste this link into the URL box **https://mt1.google.com/vt/lyrs=s&x={x}&y={y}&z={z}**

d. Click OK

e. Google maps should now appear in the **Browser window**. Click and drag it into the map area to display it.

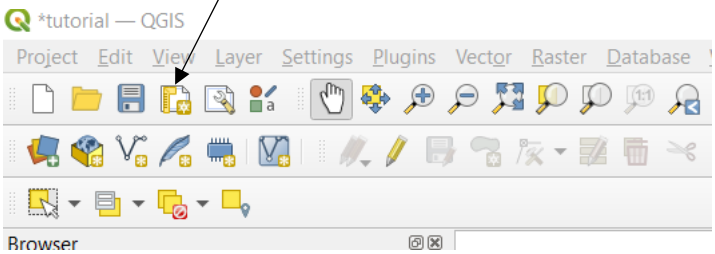


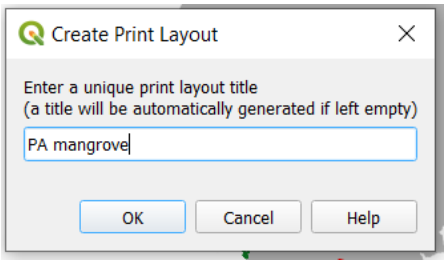
2.10. Map Layouts

Once all the layers have been symbolised, a map composition can be created. The layers will appear in the map layout as they do in the map view, so this is where we choose effective colours and symbols. The Layers can either be renamed in the Table of Contents or later when adding the legend to the map composition.

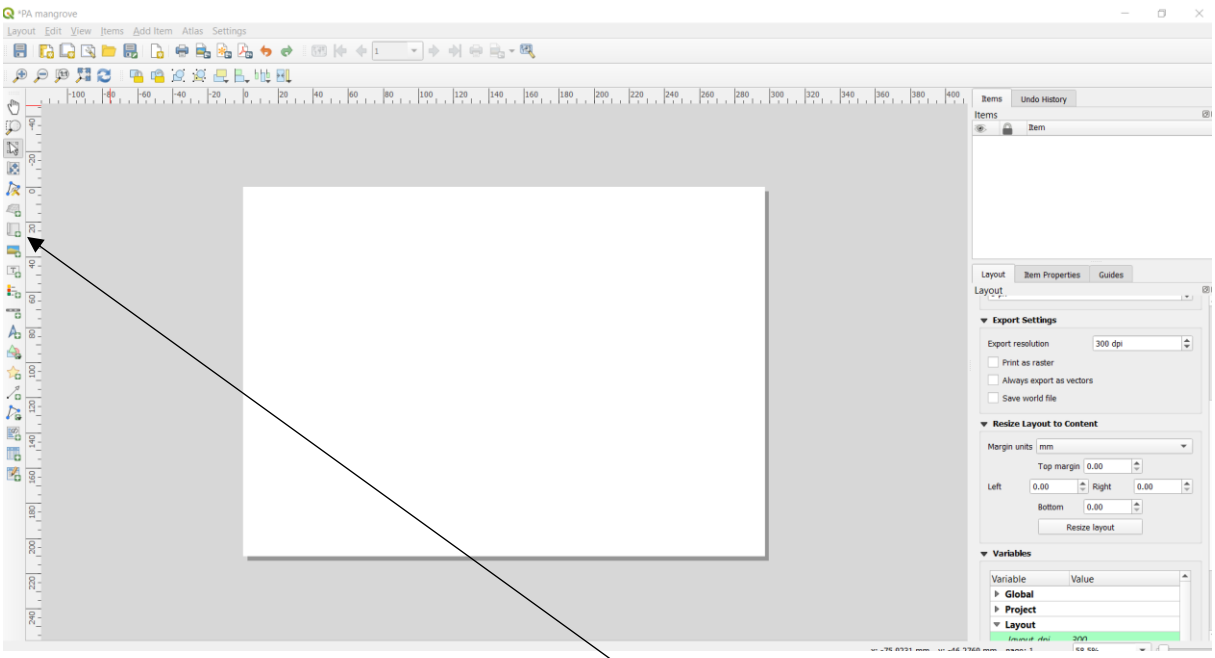
a. Click on the **New Print Composer** button.

b. Enter a title for the composition.





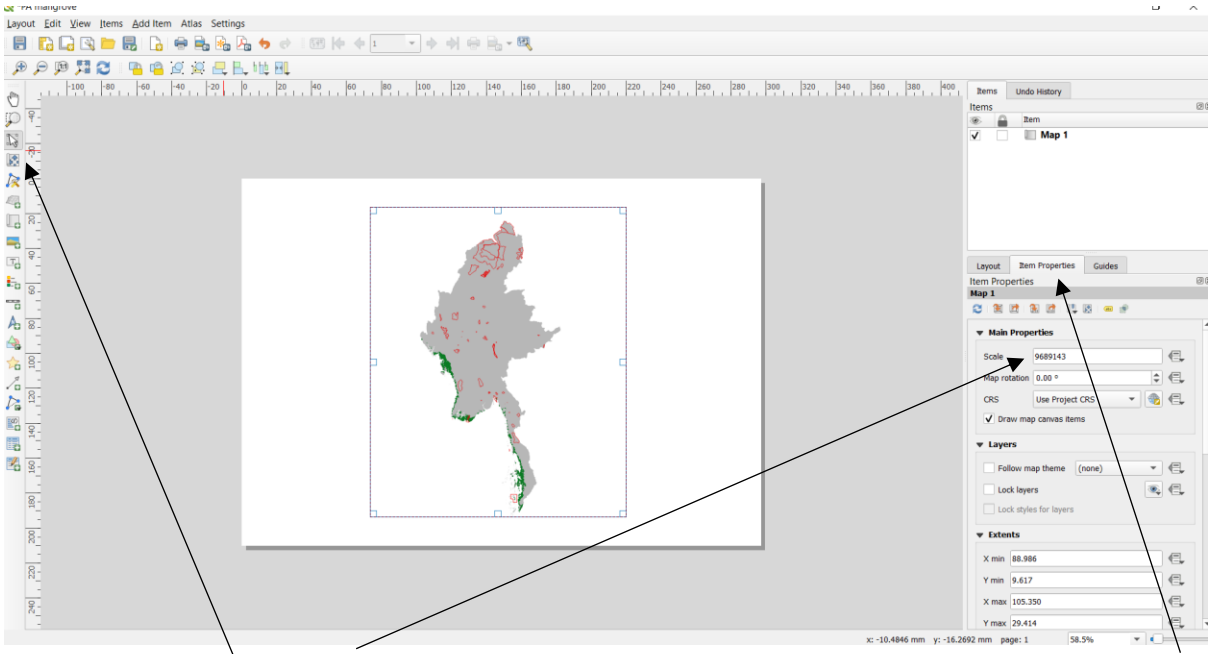
An empty composer window opens with a white canvas.



Now we will **add a map** to the canvas

a. Click the **Add new map** button on the left of the screen.

b. **Draw a box** onto the map canvas using the mouse. The map will appear in this box.

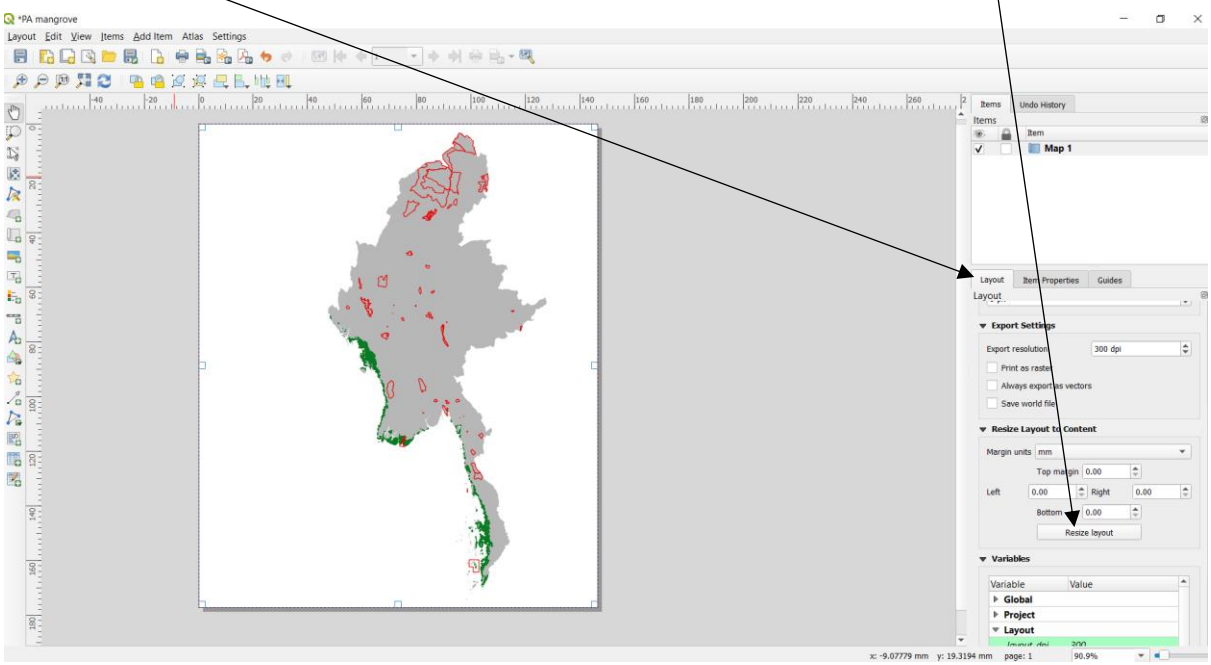


c. Change the **Map scale** to a more appropriate scale for the composition on the item properties tab.

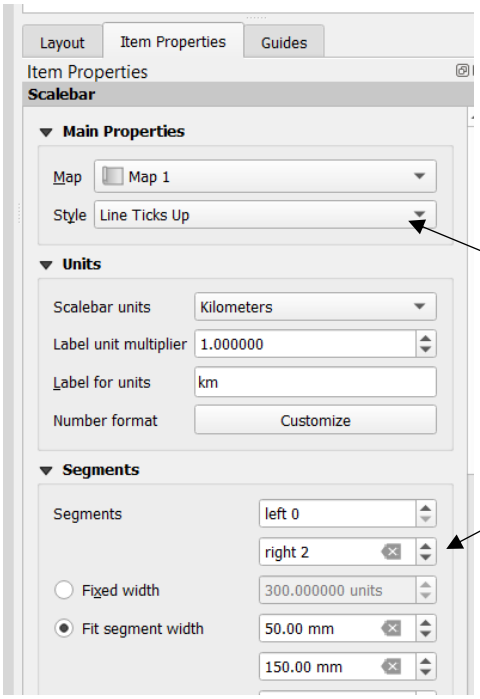
(A higher number will zoom out and a lower number will zoom in)

d. Click the **Move item content** button to pan the map to the desired extent. 

e. One you are happy with extent within its box, you can click the **Resize layout** button on the **Layout** tab and the page will be resized to the map box.

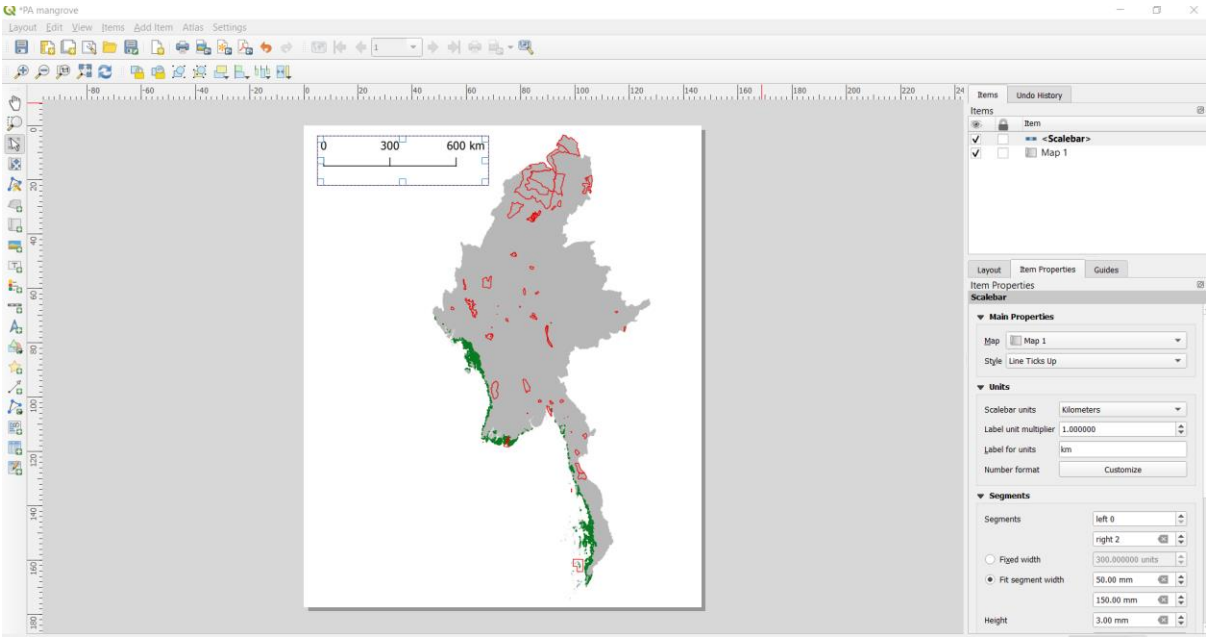


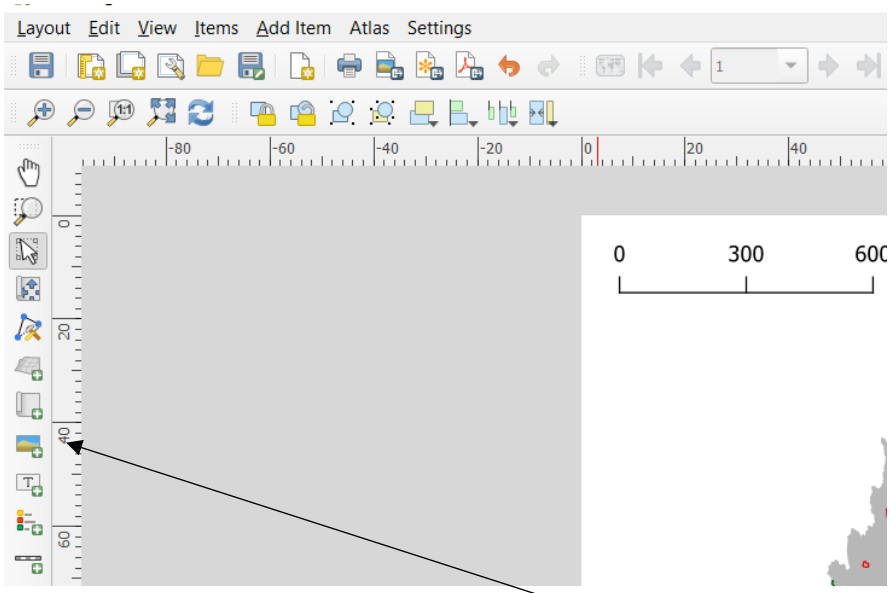
Next **add a Scalebar** to the map.



a. Click the **Scalebar** button
b. **Click and drag on the map layout** to position the scalebar.
c. You can alter the scale bar in the item properties tab on the right of the screen
d. Change the style of the scale bar to **Line Ticks Up**
e. Change the number of segments the scale bar has

The scalebar should look small and neat, change the size if you want to make a shorter scalebar.

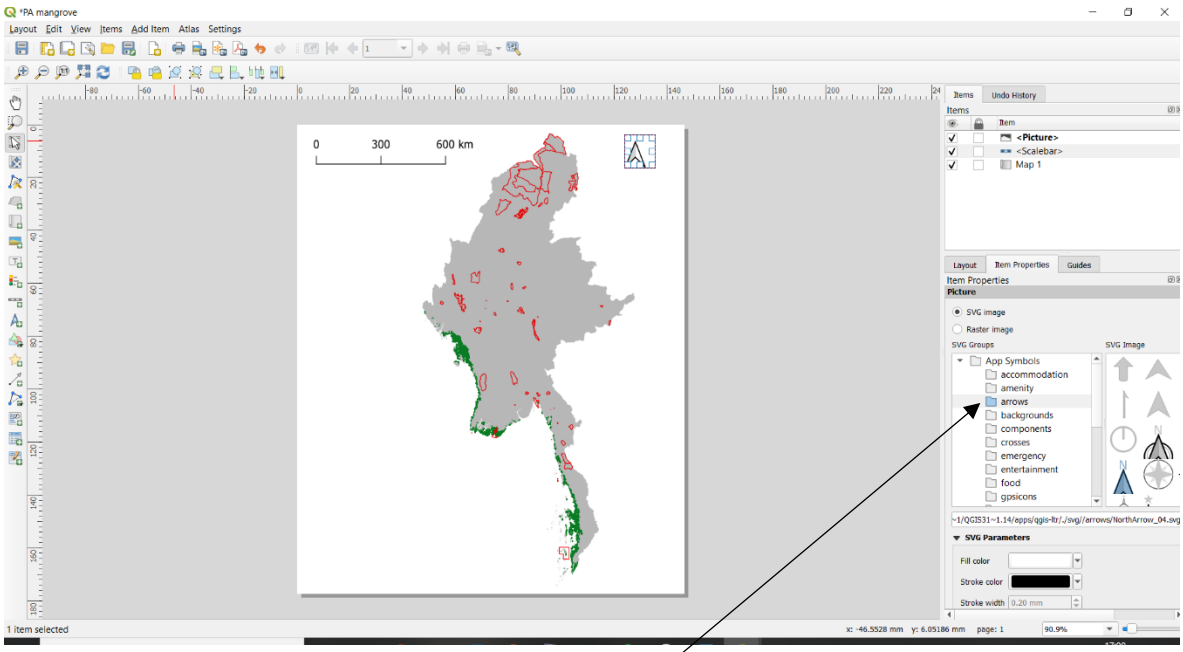




Next Add a **North Arrow** to the map:

a. A North Arrow is added as a picture. Click on the **Add picture button.** 

b. **Drag a box** onto the map canvas using the mouse of roughly the size and shape desired.

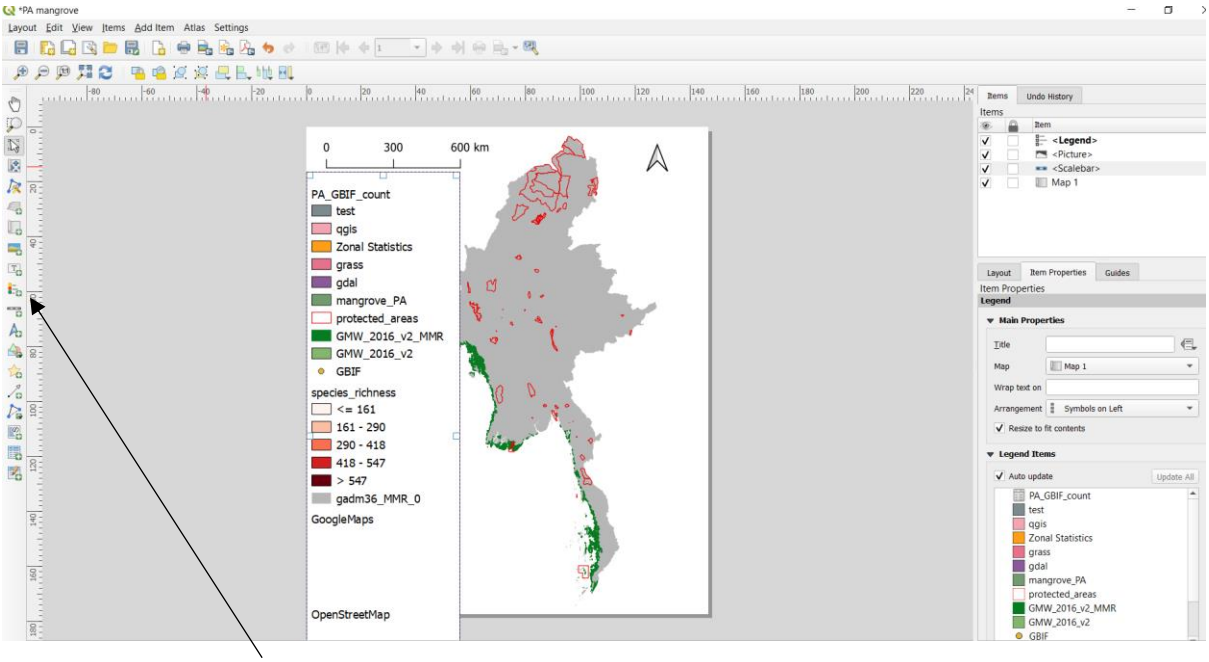


c. Click on **Arrows** in the Picture window and scroll down to find the arrow you want. Click to add a North Arrow of your choice.

d. The symbol will appear in the box that you created. **Adjust the box size** to change the dimensions of the arrow.

The North arrow should look small and neat as on the example below.

Next add a **Legend** to the map.

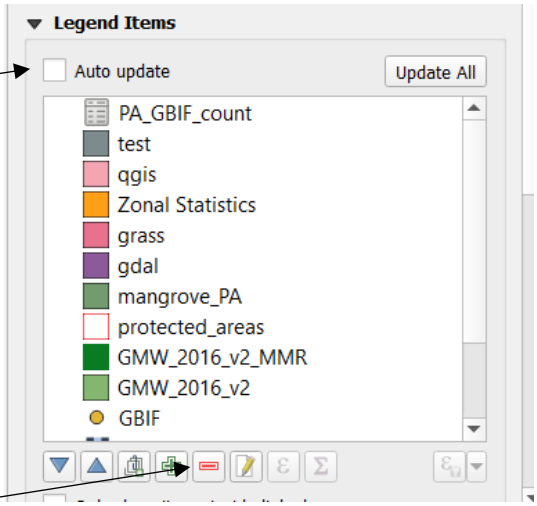


a. Click on the  **legend** button and drag a box where you would like to place it.

The initial legend includes every item present in the table of contents in the data view.

b. The **Legend items** tab will appear on the right.

c. **Untick** Auto Update.

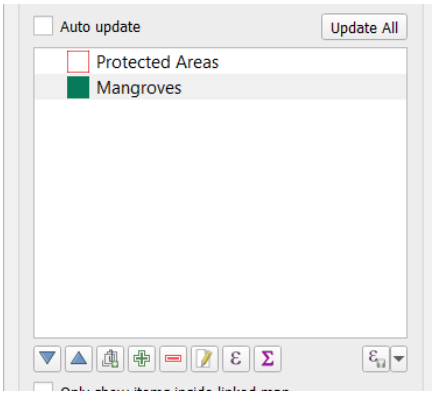


You may not want all the layers in your QGIS project to be displayed in the legend, depending on what is included in this particular map layout.

d. **Click on any layers to be removed from legend**

e. To remove an item, select it and click the **'-'** button to remove them.

The legend should now look smaller and with fewer layers, showing only the legend for layers that appear on the map (depending on what you have removed).



f. You can rename the legend items to a more appropriate name by double clicking on them

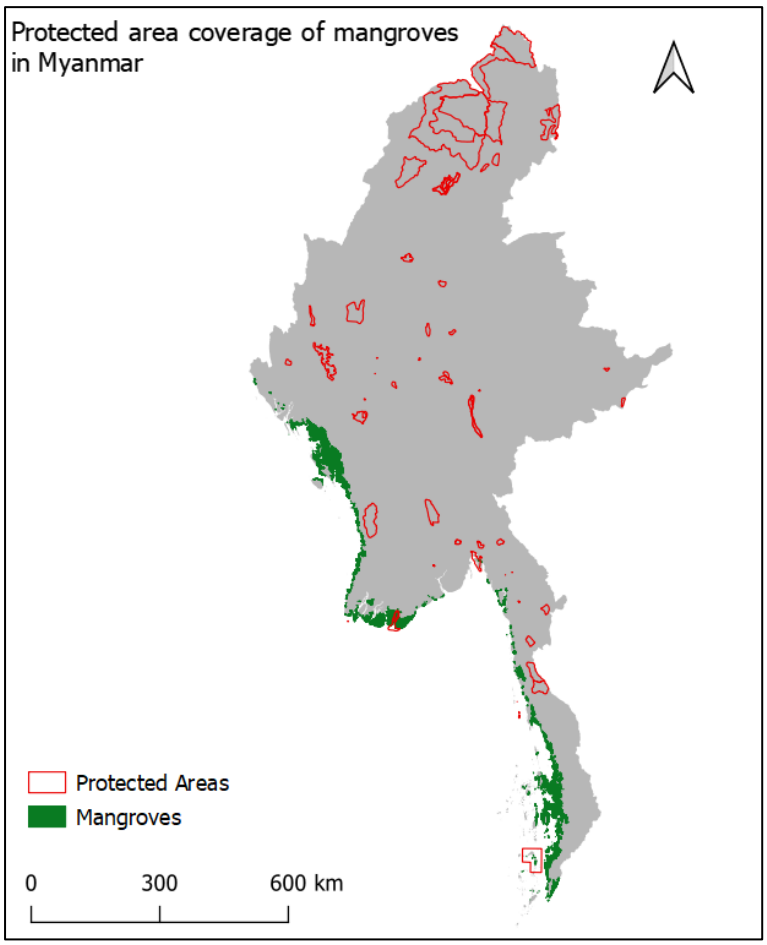
g. Click on the **Select/Move** button  to select and move the legend

h. Next add a title to the map, using the **add text**  button.

i. Finally, from the main menu click **Layout>>export as image** to a common image format such as jpeg or tif file.

This tutorial has only provided a very quick introduction to the map composer and there are many other features which are worth spending the time to explore.

Example map:



2.11. Further resources

http://www.qgis.org/en/site/forusers/trainingmaterial/index.html

https://docs.qgis.org/3.28/en/docs/training_manual/index.html

http://www.qgis.org/en/site/forusers/support.html

https://anitagraser.com/category/gis/qgis/