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

PROCESSING AND VISUALISING FIRE DATA TO IDENTIFY POTENTIAL PRESSURES FROM FIRES ON FOREST USING QGIS V 2.18

UN-REDD PROGRAMME
Food and Agriculture Organization of the United Nations
UNDP
UN environment

The UN-REDD Programme is the United Nations Collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. The Programme was launched in September 2008 to assist developing countries 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).

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) is the specialist biodiversity assessment centre of the United Nations Environment Programme (UNEP), the world's foremost intergovernmental environmental organisation. The Centre has been in operation for over 30 years, combining scientific research with practical policy advice.

Prepared by Corinna Ravilious, Barbara Pollini and Xavier de Lamo

We welcome comments on any errors or issues. Should readers wish to comment on this document, they are encouraged to get in touch via: ccb@unep-wcmc.org.

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Contents

1. Introduction

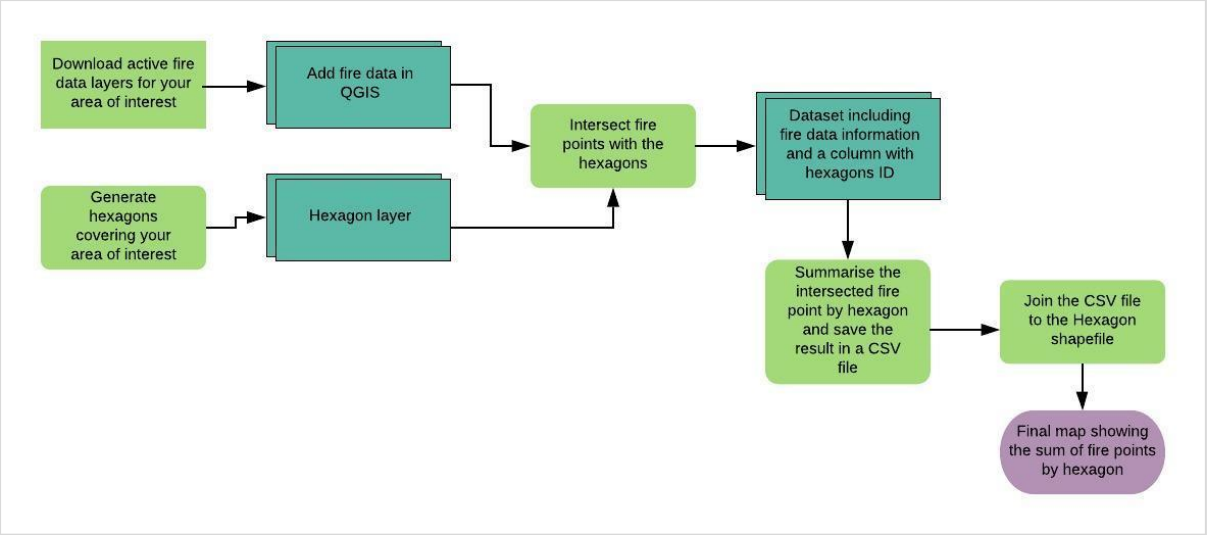
REDD+ has the potential to deliver multiple benefits beyond carbon. For example, it can promote biodiversity conservation and secure ecosystem services from forests such as water regulation and non-timber forest products. Some of the potential benefits from REDD+, such as biodiversity conservation, can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

Open Source 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 allow 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 open source QGIS, 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 http://bit.ly/mbs-redd for country materials). There is of course no requirement for countries to use the approaches described in these tutorials.

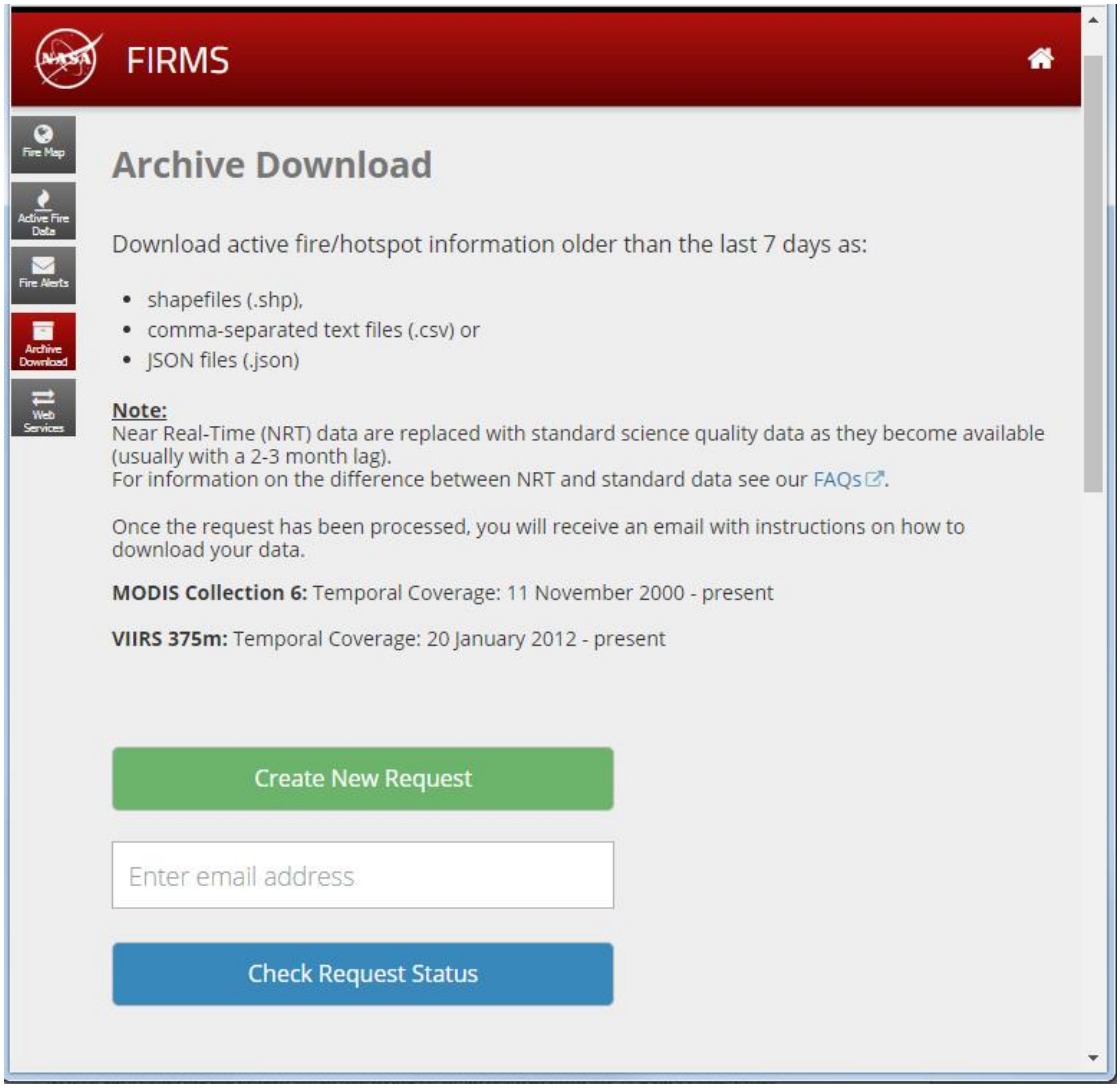
Fire can be a direct driver of deforestation and forest degradation. It can be natural, for example the result of an extended period of drought, or result from human activity where fire is used for activities such as pasture management, land preparation or clearing for cultivation. Whatever the initial cause, fires may also create further opportunity for activities such as agricultural expansion when fire spreads outside of target areas opening up new areas of land (Maukonen et al., 2010). This tutorial demonstrates how to map areas under pressure from fire using the fire hotspots data from the Fire Information for Resource Management System (FIRMS). Whilst this tutorial shows how to map areas affected by fire, further analysis would be required to understand and identify the causes of the fire and to define effective actions to address the driver. There are many other databases to get fire data (e.g. all MODIS fire products, USA), which are equally valid. This manual uses the FIRMS data as example.

The analysis runs entirely in the QGIS version 2.18 (www.qgis.org). Below an image showing the key steps to carry out this analysis



2. Request and download active fire data layers

a. Go to the website https://firms.modaps.eosdis.nasa.gov/download/ to download data from the FIRMS Archive download.

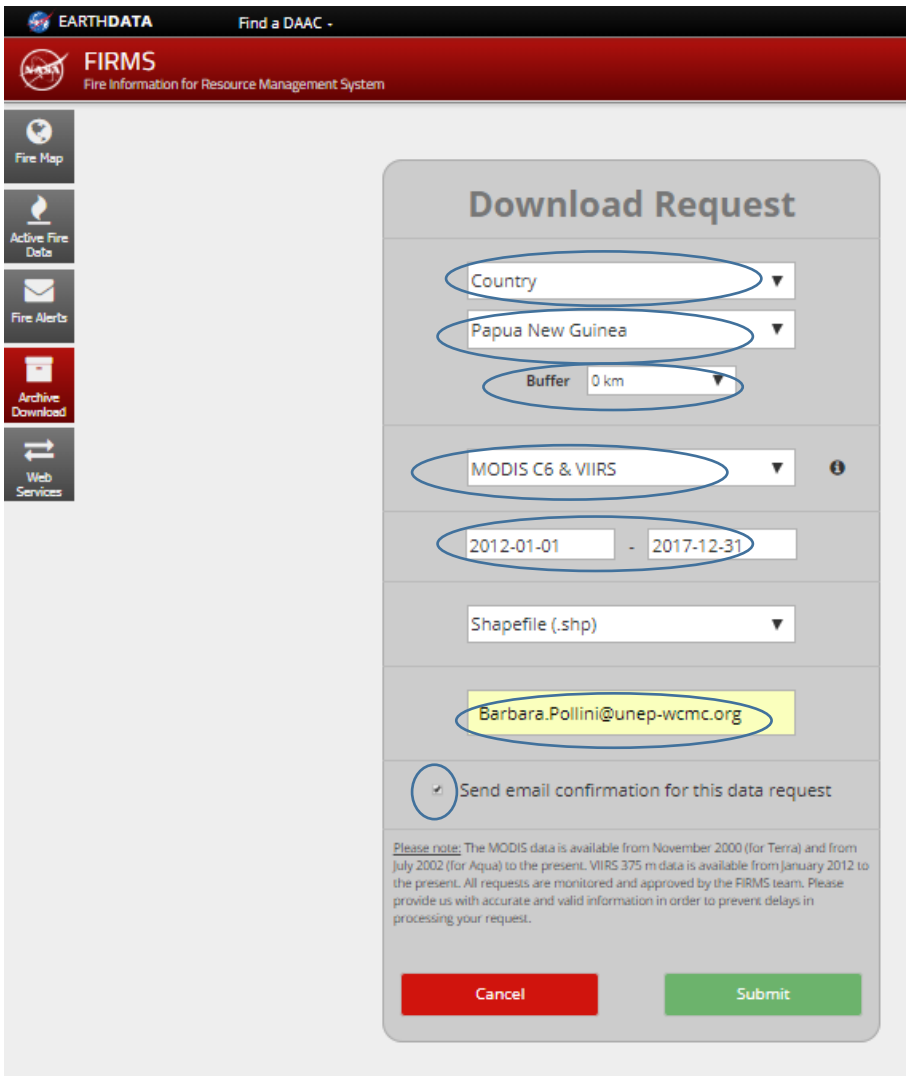


Note: there are two different active fire/hotspot datasets available. For historical data prior to January 2016, you will need Modis C6. VIIRS data are a newer product at a higher spatial resolution (375m compared to 1km) which therefore potentially provides a more accurate fire detection. At present, being a relatively new product, it is currently considered an experimental product.

Further information on both MODIS (C6) and VIIRS are available at the links below:

https://viirsland.gsfc.nasa.gov/PDF/VIIRS_activefire_User_Guide_v1_3.pdf
https://cdn.earthdata.nasa.gov/conduit/upload/3865/MODIS_C6_Fire_User_Guide_A.pdf

b. Click on the green button **Create New Request**.
You will be presented with a **Download Request** form.



In this example we request to download country information:

c. Change the selection from **World** to **Country**

d. Choose your country of interest e.g. in this example, **Papua New Guinea**

e. Choose the **Buffer** around each fire point. For this example leave 0, but you have the option to select 0km, 5km, 10km and 15km buffer.

f. Choose the Fire Data source, in this example we will download both **MODIS C6 & VIIRS**

g. Select the date ranges. E.g. in this example we have picked a 5 year time period from **1st January 2012 to 31st December 2017.**

h. Leave the output format as **Shapefile**

i. Enter **your email address**

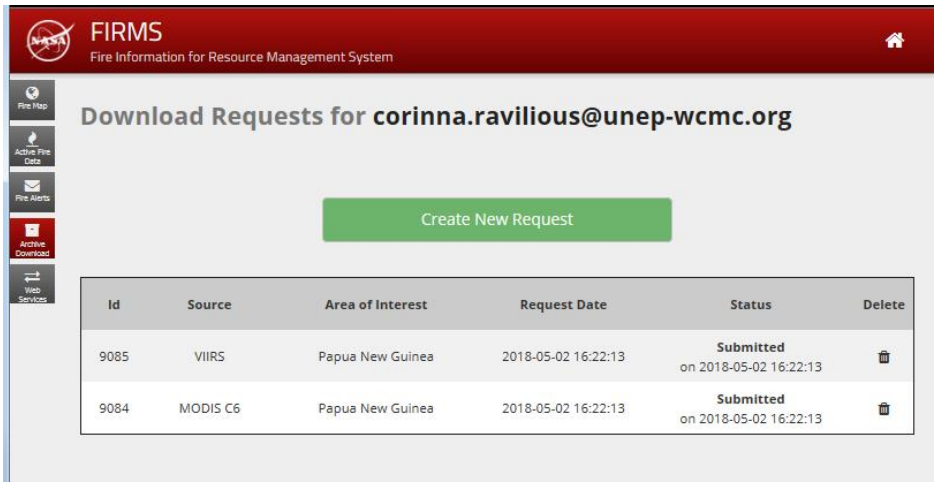
j. Leave the **tick** to receive a confirmation email about your request

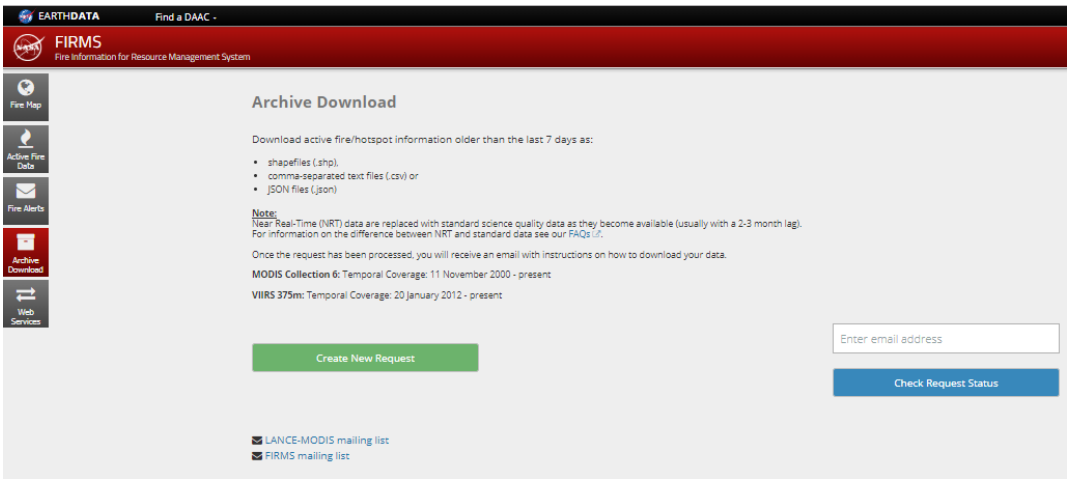
k. Click the green **submit** button to submit your request

You now need to wait for an email to say that your request has been processed.

l. If you want to check the status of your requests you can go to the url https://firms.modaps.eosdis.nasa.gov/download/

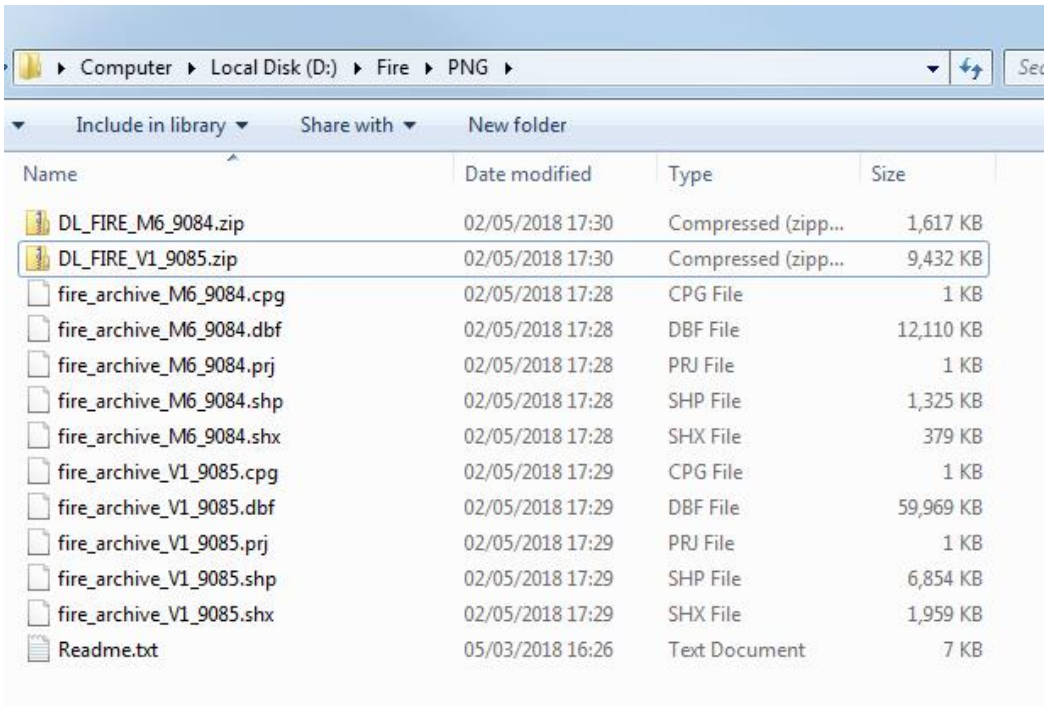
m. Enter your email address and click on **Check Request Status**





n. You should receive an email from FIRMS confirming your download request is complete. The email will contain a download link to a zip file containing the active fire point data. If you have requested more than one dataset, each dataset will be sent in a separate email.

o. **Download** and **unzip** the file(s).

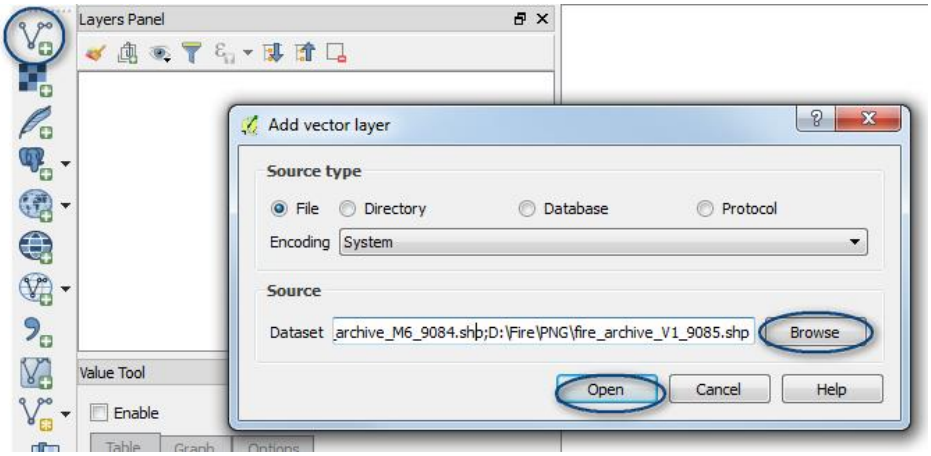


2.1. Add active fire points to QGIS project

The fire data points represent the centre longitude/latitude of 1km pixels flagged as containing one or more fires. Each point contains an attribute FRP (Fire radiative power) showing the amount of heat output from the fires within the 1km pixel. This is measured in MW (megawatts).

a. Click on the **Add Vector layer** button and click on **browse** to navigate to the active fire point layer(s)

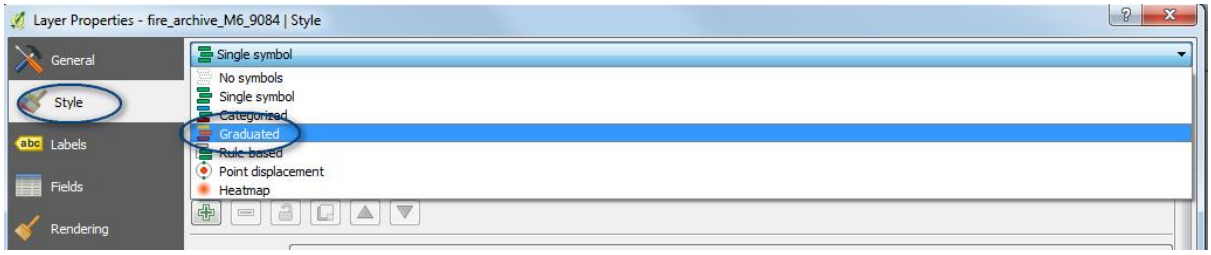
b. Click **Open** to add the data to your QGIS project



2.2. Style the fire points based on intensity of fire

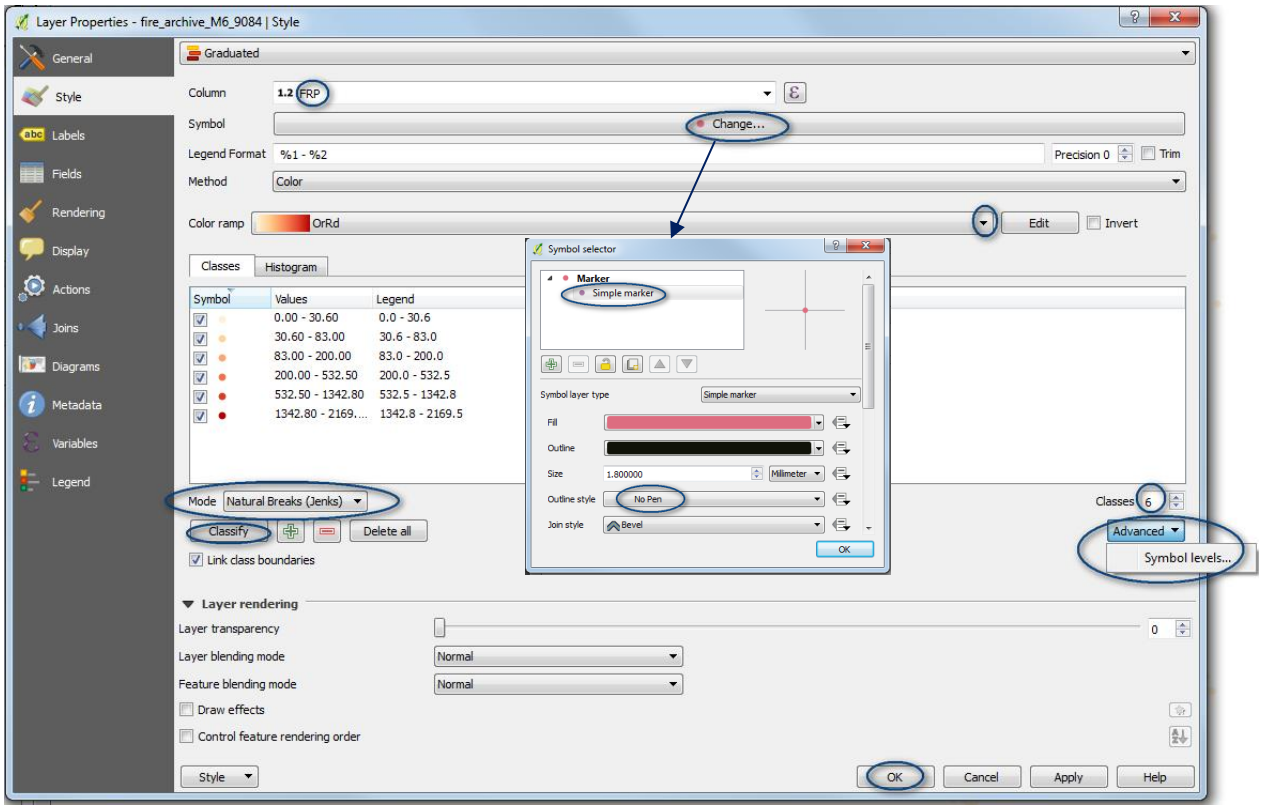
a. In the layer panel right click on the fire points layer and click on **Properties**. This will bring up the **Layer Properties** window.

b. Click on the **Style** tab and change from **Single symbol** to **Graduated**



c. Next to **Column**, choose the field **FRP** to shade the data based on Fire Radiative Power.

d. Next to symbol click on **Change…** and change the marker outline style to no pen so that the data are presented as a solid filled circle without an outline.



e. Next to **Color ramp** change the symbology to a **yellow-orange-red** ramp

Change the classification **Mode** choose the method for categorizing the data for display e.g. in this example **Natural Breaks (jenks)** has been chosen.

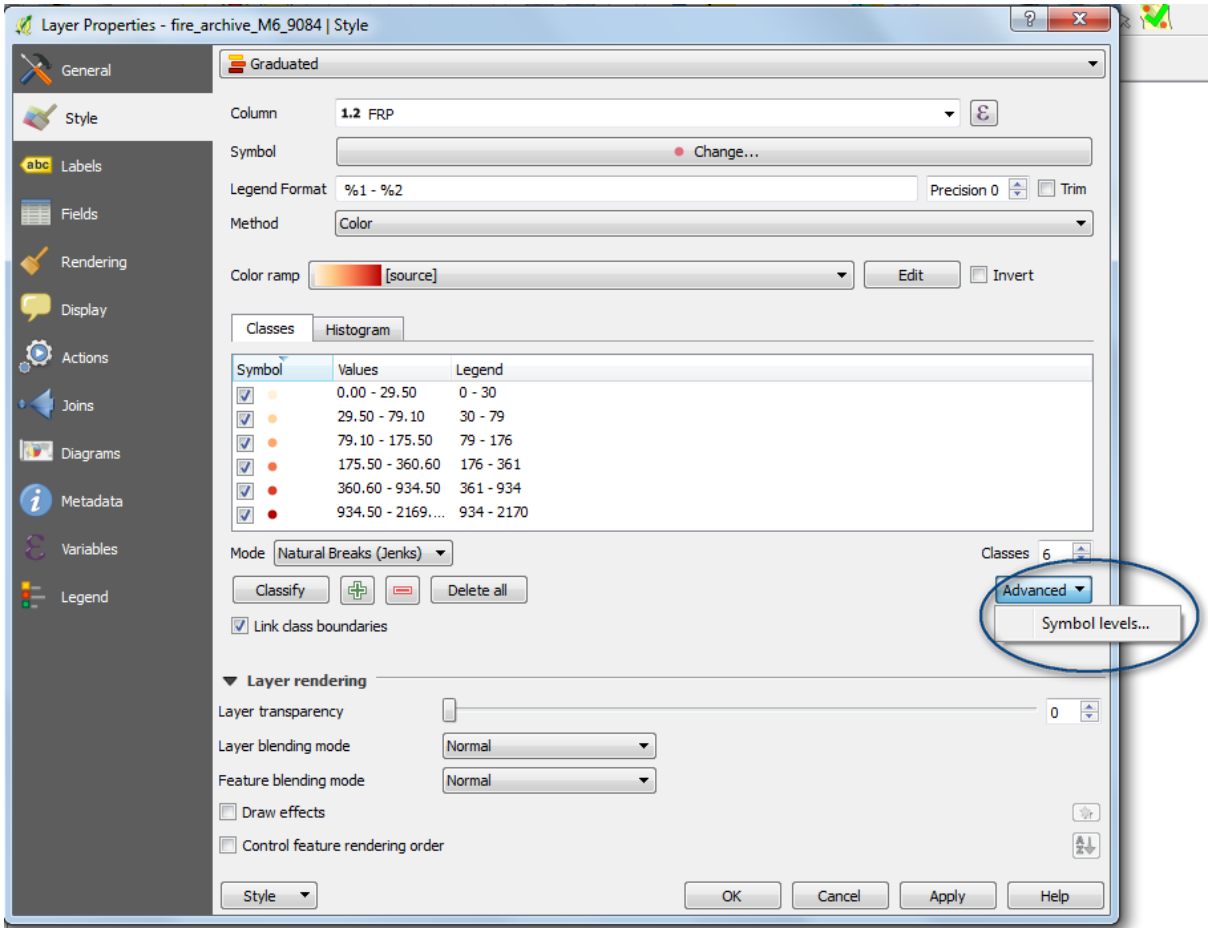
f. Change the no of **Classes** to **6** (or the number of classes you want)

g. Click **Classify** to apply the chosen classification to the data.

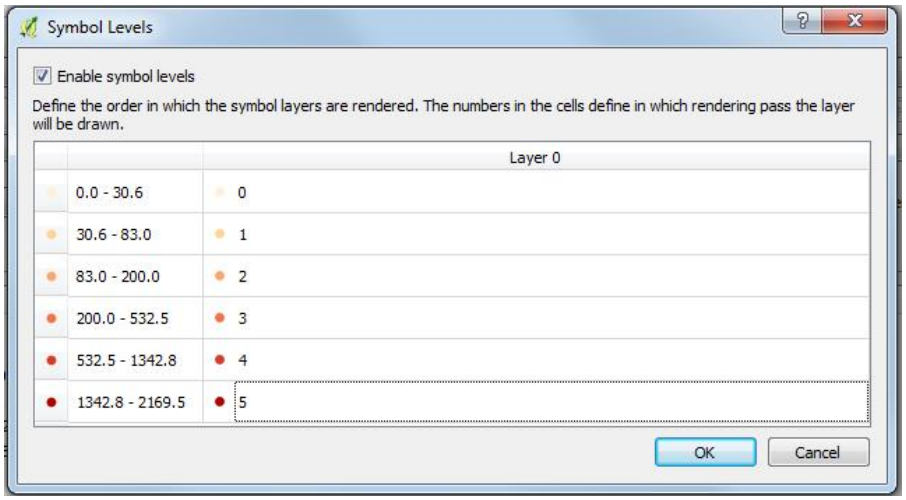
h. Click OK

When the fire points are drawn you will notice that there are many points which fall on top of each other and that the points with the lower FRP value are drawn last. This does not give a good visualisation of the data if you want to see where the most intense fires occurred.

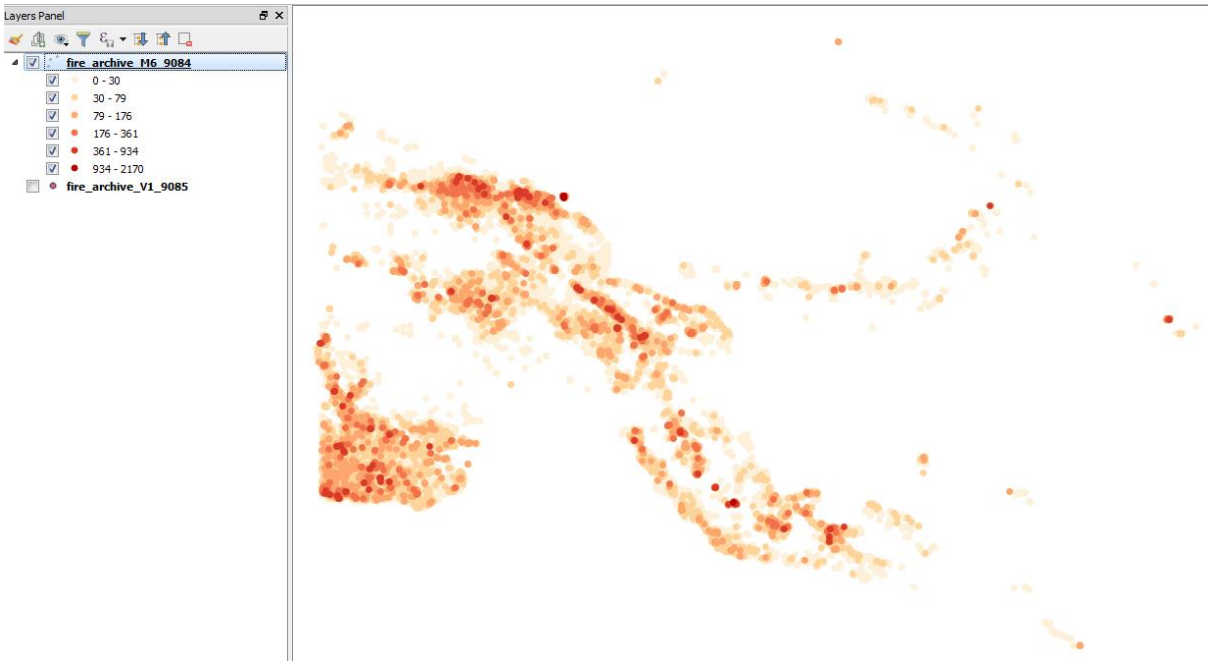
i. Right click on the fire data layer in the Layers Panel and click on **Advanced>>Symbol levels**



j. In the symbol levels window, the number in on the right shows the order in which to draw the symbols. They are all initial set to 0. Change the numbers sequentially i.e. so the class that draws first remains at 0 and the class that draws last has a value of 5.



The Fire data now display with the highest FRP points drawn last:



This classification method shows the maximum intensity of fire at a particular location but does not show the number of fires at each location.

2.3. Generate hexagon grid and summarise fire data based on intensity and density

To assess fire impact over the 1-year period that gives a measure of both intensity and density of fire points over the period, a vector grid of hexagons can be generated and used to tabulate the intersection of the fire points within each hexagonal polygon.

2.3.1. Project fire data to an equal area projection

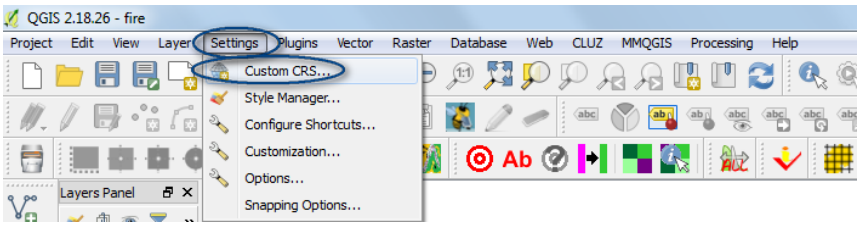
The hexagons need to be generated in an equal area projection. The fire data points are currently in Geographic coordinate system (EPSG 4326). Therefore, the first step is to change the projection (CRS) of the fire data.

For country level analysis if your country crosses only one UTM zone then you can use a UTM (Universal Transverse Mercator) as UTM is an equal area projection. However, if your country crosses more than one UTM zone then Lambert Azimuthal Equal Area projection is a good option. You will need to define a **custom CRS** as this projection requires you to set a central latitude and longitude.

Papua New Guinea crosses 3 UTM zones therefore in this example we will use a custom Lambert Azimuthal Equal Area projection with a latitude of -6 and a longitude of 148.

If your data needs a custom CRS follow steps a – c below; otherwise, go straight to step d.

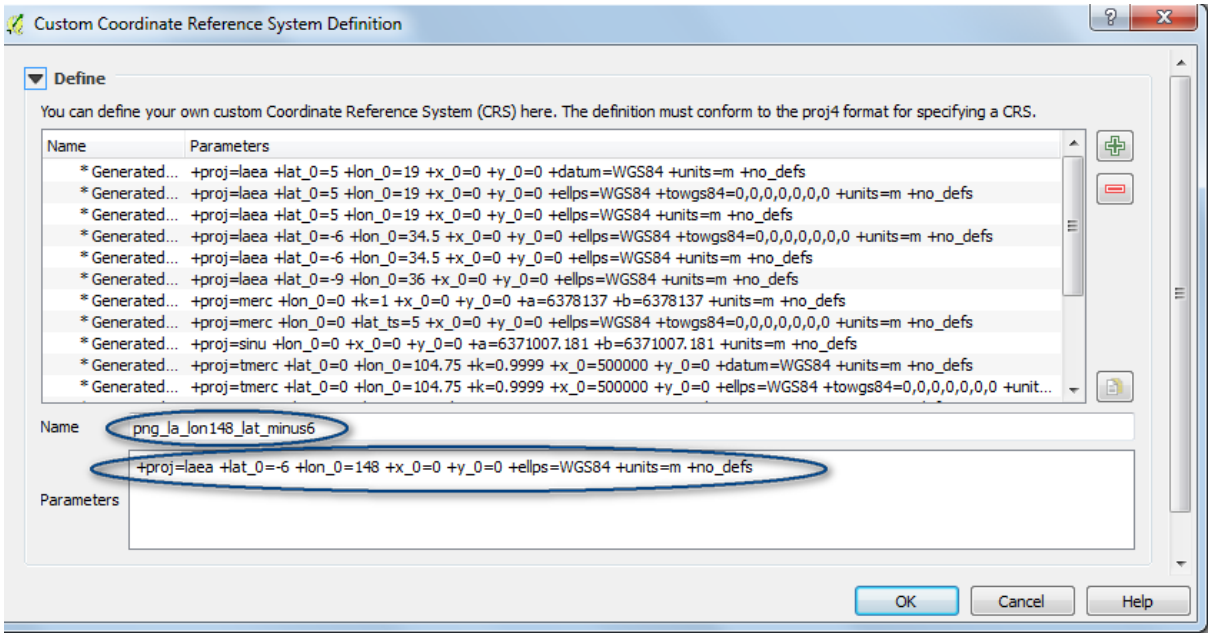
a. from the main menu click on **Settings>>Custom CRS**



b. Click "+" and then under the **Name** tab give your CRS a name e.g. in this example **png_la_lon148_lat_minus6**

c. Under Parameters use the following syntax for Lambert Azimuthal Equal Area projection (changing the lat_0=-6 and the Lon_0=148 to the centre latitude and longitude of your area of interest):

+proj=laea +lat_0=-6 +lon_0=148 +x_0=0 +y_0=0 +ellps=WGS84 +units=m +no_defs



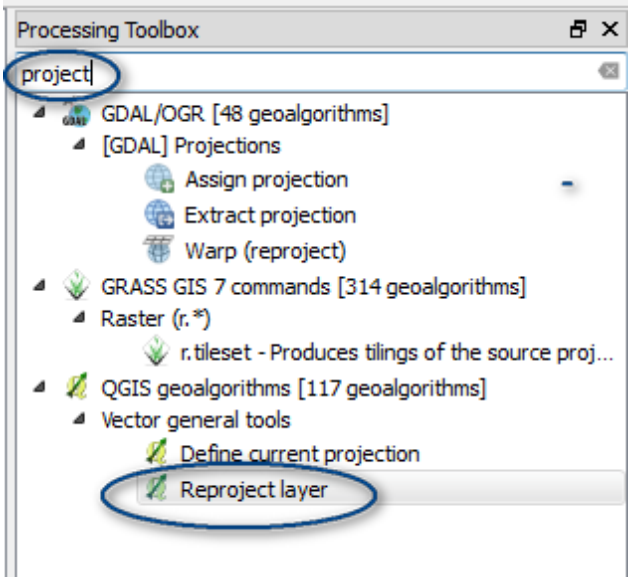
d. In the processing toolbox search for **project** tools

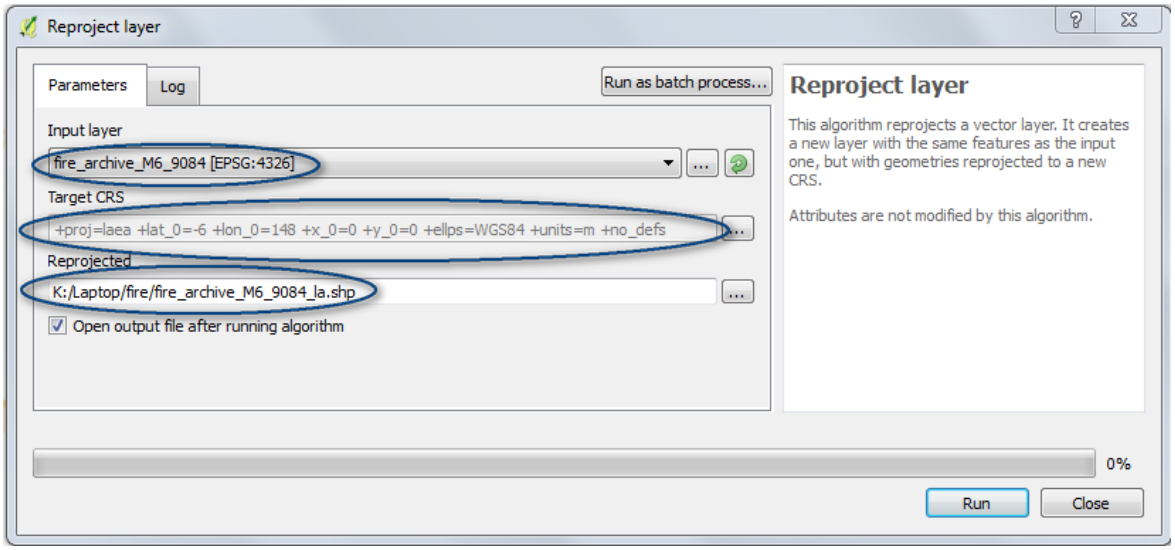
e. Double click on the **Reproject layer** tool under the vector general tools in the **QGIS geoalgorithms**

f. Select the fire points as the input layer

g. Select the target CRS i.e. the Equal Area projection, in this example the Lambert Azimuthal Equal Area projection defines in steps a-c.

h. Navigate to an output folder and give the projected dataset a new name. In this example it is the same as the input dataset name but with an ending _la.



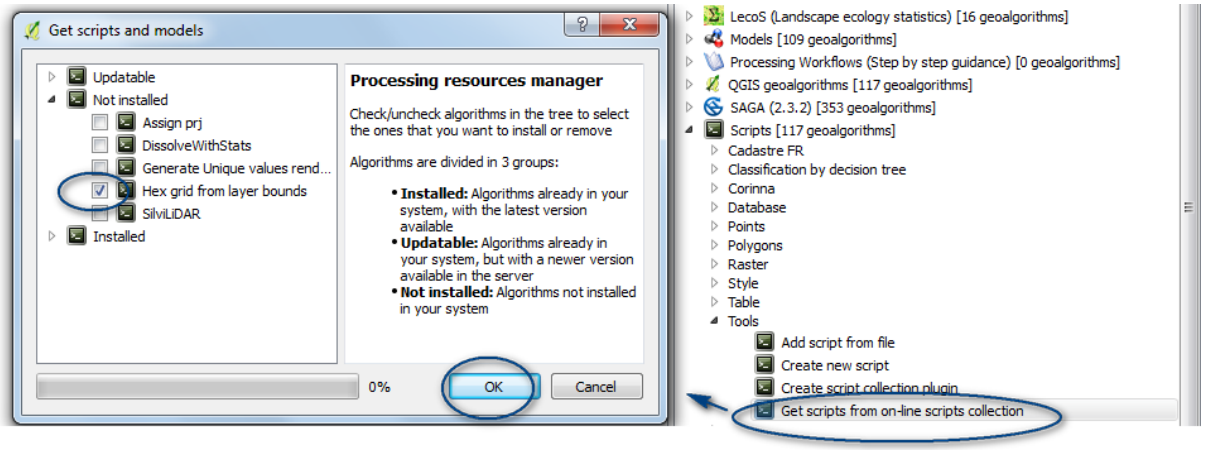


2.3.2. Generate 10 km^2 hexagons

There is no tool for generating hexagons in the processing toolbox but there is a script available in the on-line scripts collection.

a. In the processing toolbox expand **Scripts**

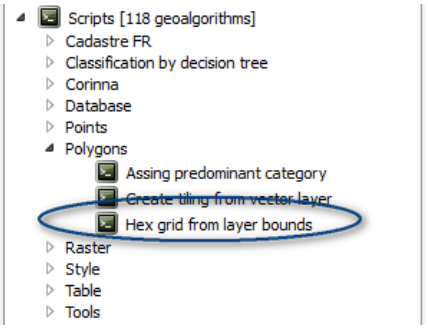
b. Expand **Tools** and double click on **Get scripts from on-line scripts collection**



c. In the **Get scripts and models** window expand Not Installed and tick **Hex grid from layer bounds**

d. Click **OK**

The script will have been added under the **Polygons** section of the Scripts. If you cannot see it, close your project and open QGIS again.

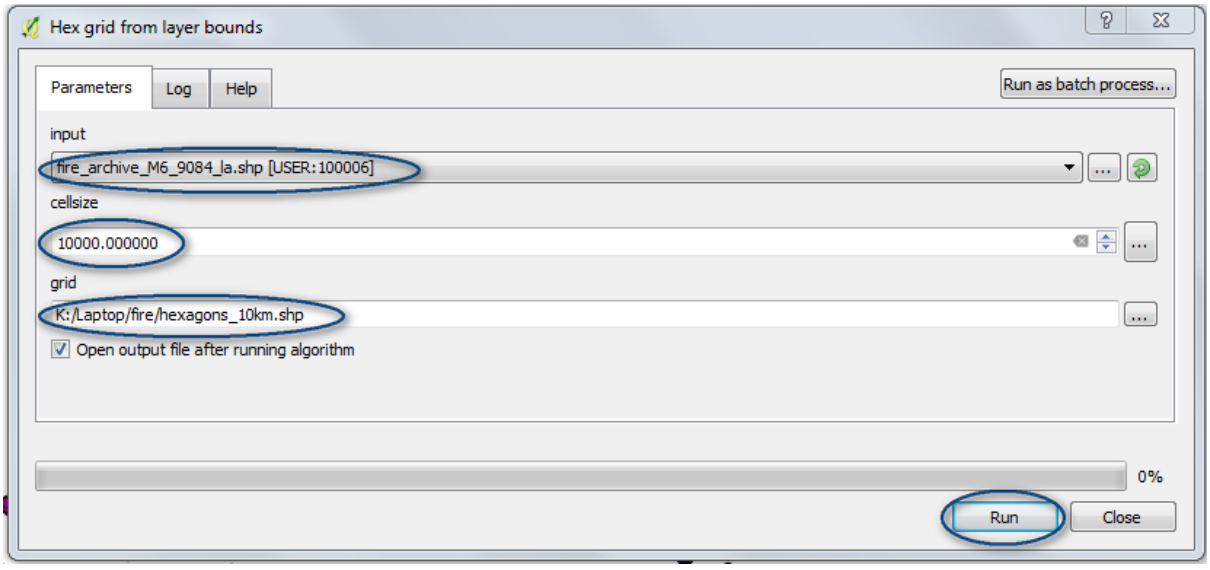


e. Double click on the **Hex grid from layer bounds** script.

f. Set the input dataset as the fire points in the equal area projection

g. Set the cellsize e.g. in this example **10000** (i.e. 10km^2)

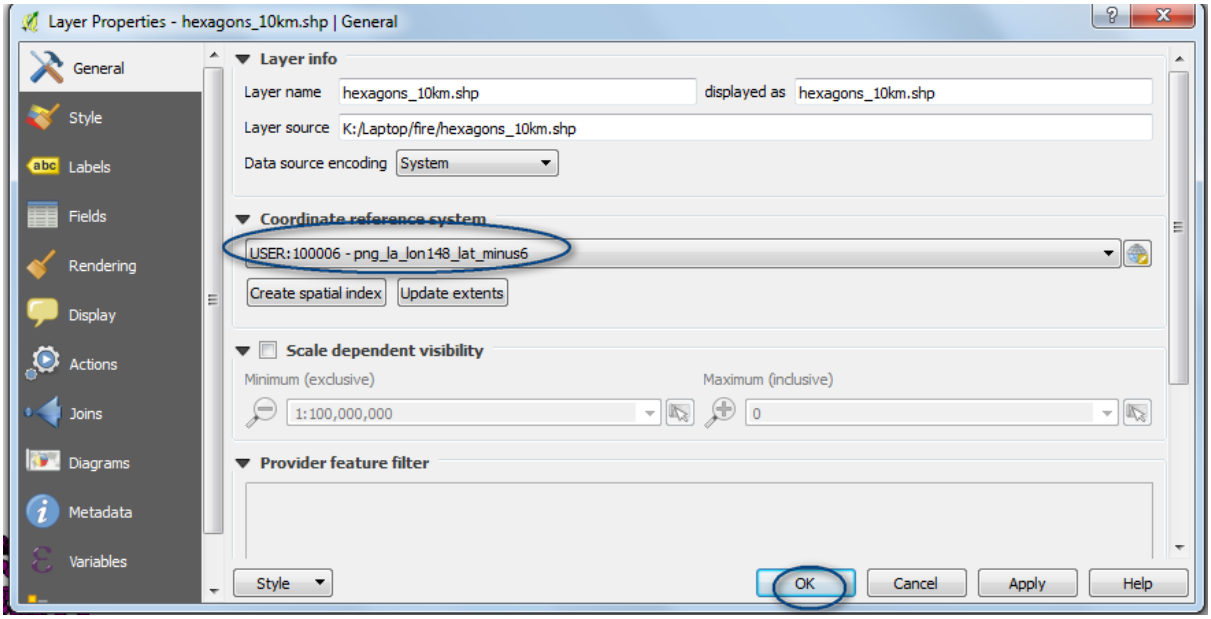
h. Navigate to an output folder and give the new dataset a name e.g. **hexagons_10km.shp**



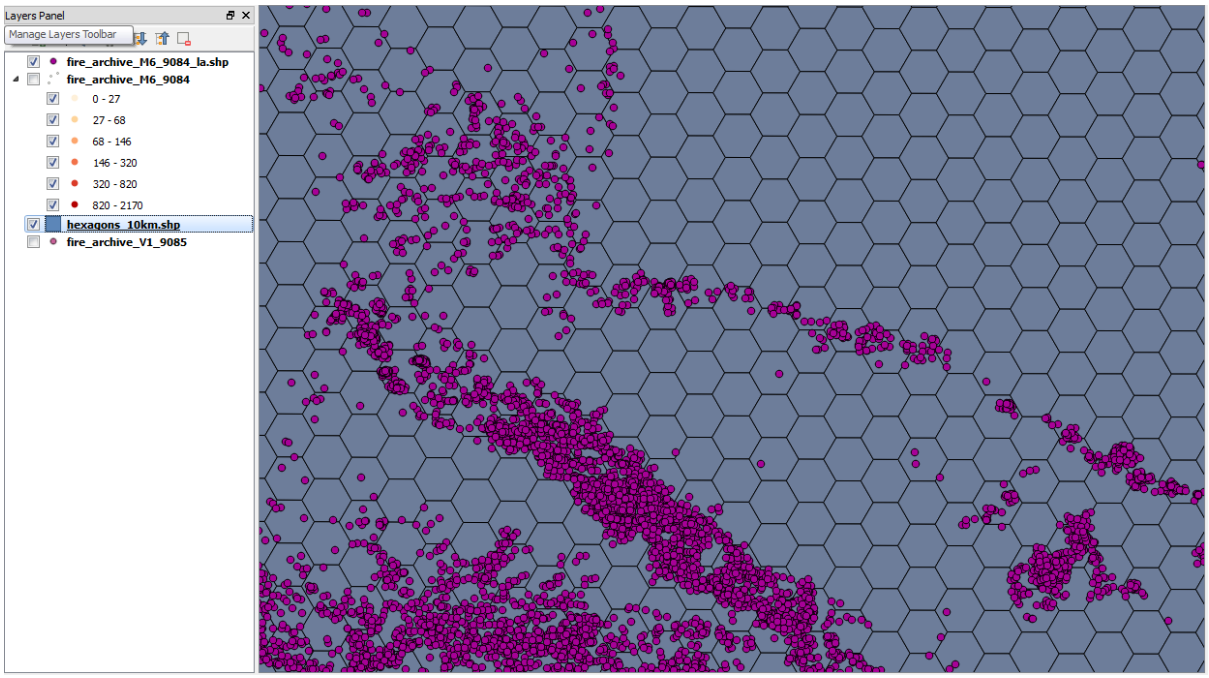
i. Click **Run** to run the tool.

j. Check that the hexagons draw. They should over the extent of the fire points.

k. If the hexagons do not draw, right click on the hexagons layer and click **properties**. The Coordinate reference system should be the equal area projection of the fire points. If it is not change it to the correct projection.



l. Click Ok and the fire points should now draw

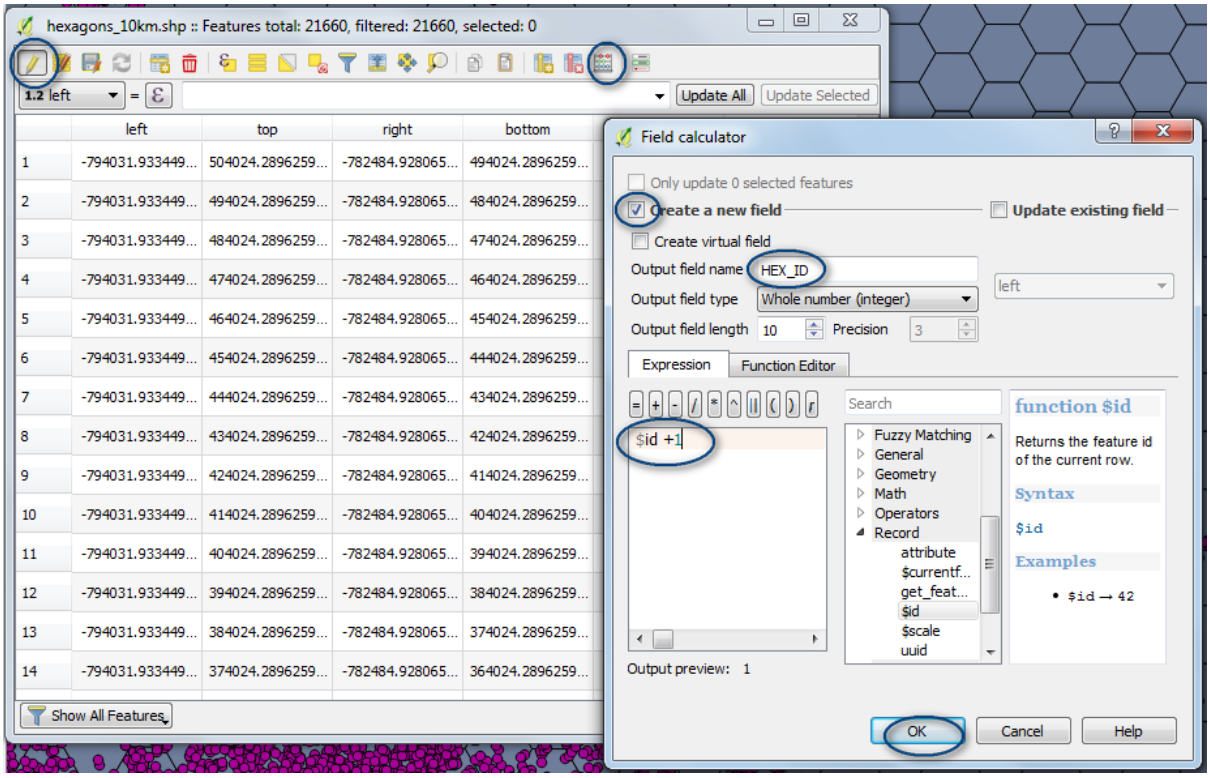


m. Right click on the hexagons dataset and click **Open Attribute Table**

n. Click on the Toggle Edit button and then on the **Open Field Calculator** button

o. In the **Field calculator** window tick **Create a new field** called **HEX_ID** and calculate the expression to be **$ID +1**

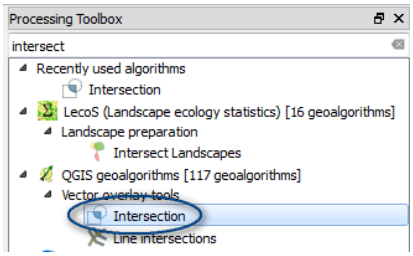
p. Click **OK** to add and calculate the field

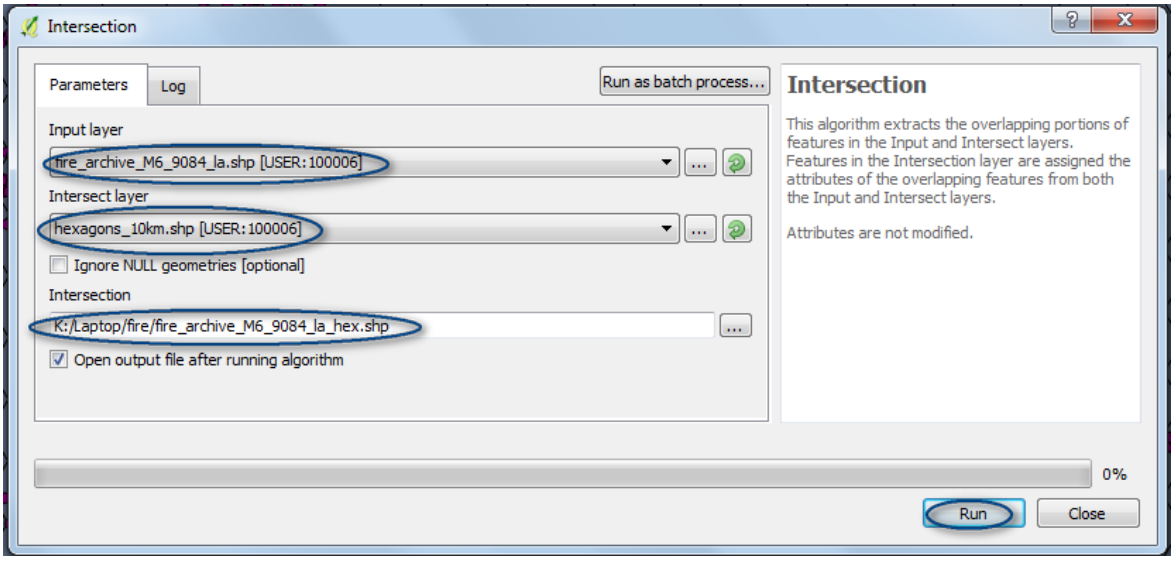


q. Click on the **Toggle edit** button again and **Save** the changes

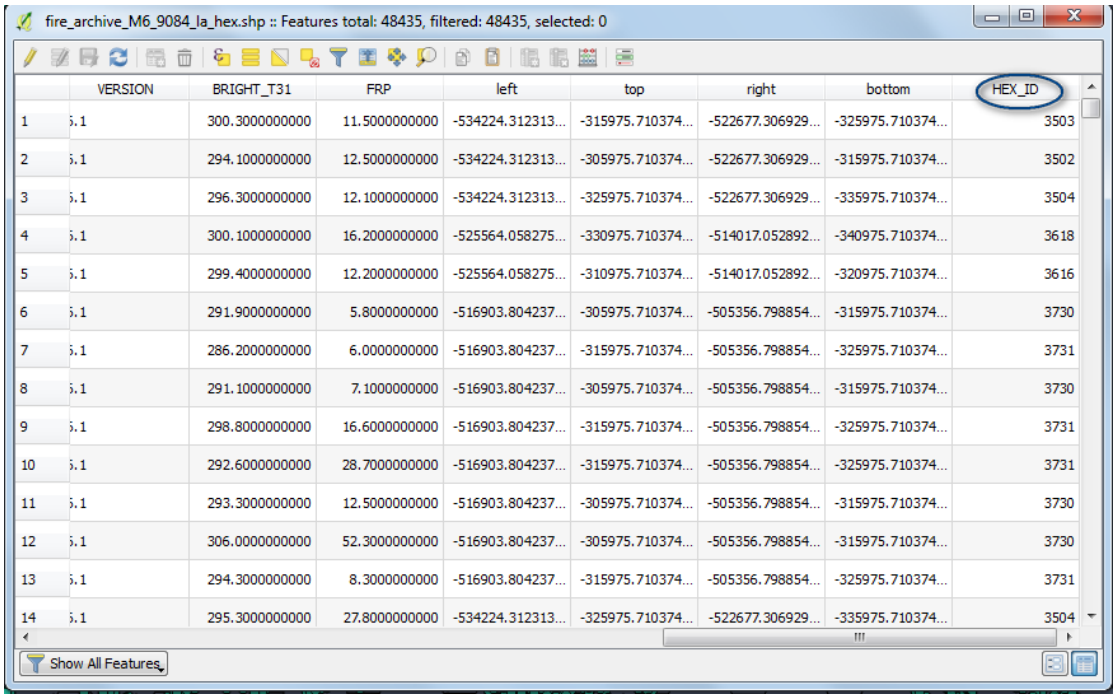
2.3.3. Intersect fire point and with 10km^2 hexagons

a. In the processing toolbox search for **Intersect**
b. Double click on the **Intersection** tool under the **vector overlay tools** in the **QGIS Geoalgorithms**
c. Set the input dataset to be the **fire points in equal area projection**
d. Set the intersect layer to be the **hexagons** file
e. Navigate to an output folder and save the output intersection layer with a new name





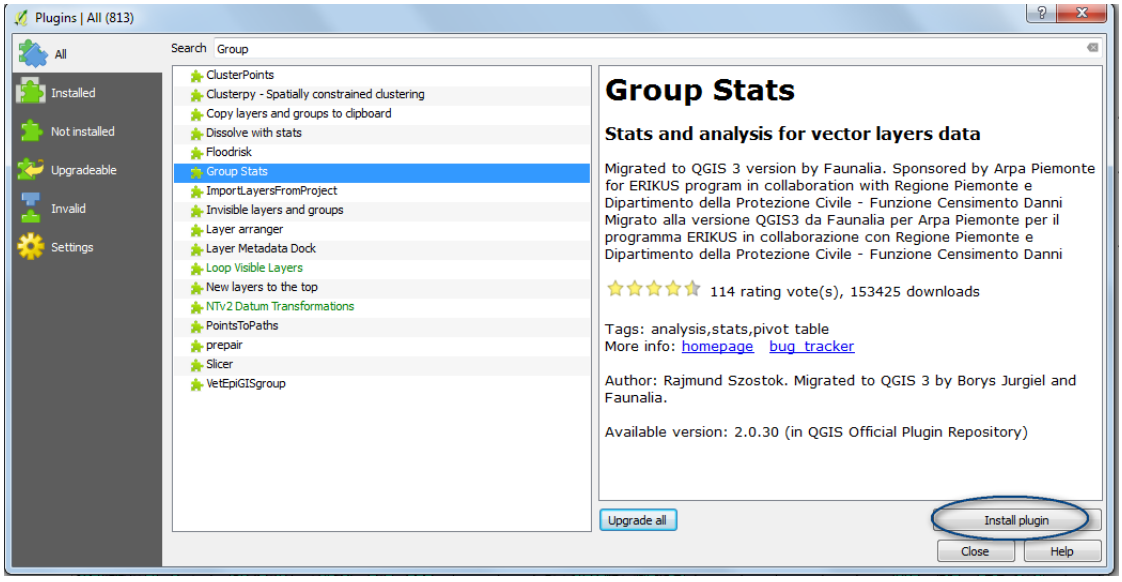
f. The output dataset is a copy of the fire points in equal area projection with the HEX_ID added. Open the attribute table to view the data.



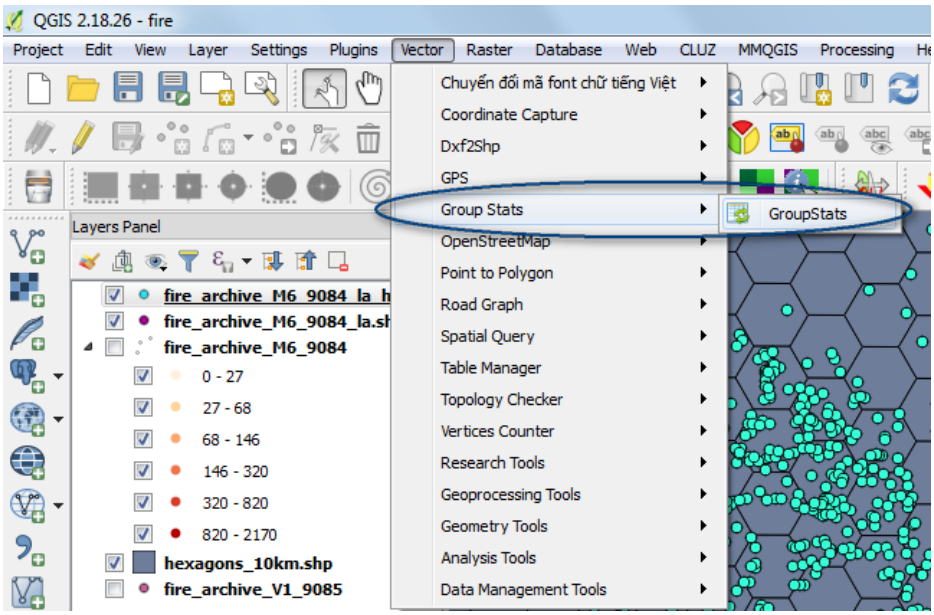
	VERSION	BRIGHT_T31	FRP	left	top	right	bottom	HEX_ID
1	6.1	300.3000000000	11.5000000000	-534224.312313...	-315975.710374...	-522677.306929...	-325975.710374...	3503
2	6.1	294.1000000000	12.5000000000	-534224.312313...	-305975.710374...	-522677.306929...	-315975.710374...	3502
3	6.1	296.3000000000	12.1000000000	-534224.312313...	-325975.710374...	-522677.306929...	-335975.710374...	3504
4	6.1	300.1000000000	16.2000000000	-525564.058275...	-330975.710374...	-514017.052892...	-340975.710374...	3618
5	6.1	299.4000000000	12.2000000000	-525564.058275...	-310975.710374...	-514017.052892...	-320975.710374...	3616
6	6.1	291.9000000000	5.8000000000	-516903.804237...	-305975.710374...	-505356.798854...	-315975.710374...	3730
7	6.1	286.2000000000	6.0000000000	-516903.804237...	-315975.710374...	-505356.798854...	-325975.710374...	3731
8	6.1	291.1000000000	7.1000000000	-516903.804237...	-305975.710374...	-505356.798854...	-315975.710374...	3730
9	6.1	298.8000000000	16.6000000000	-516903.804237...	-315975.710374...	-505356.798854...	-325975.710374...	3731
10	6.1	292.6000000000	28.7000000000	-516903.804237...	-315975.710374...	-505356.798854...	-325975.710374...	3731
11	6.1	293.3000000000	12.5000000000	-516903.804237...	-305975.710374...	-505356.798854...	-315975.710374...	3730
12	6.1	306.0000000000	52.3000000000	-516903.804237...	-305975.710374...	-505356.798854...	-315975.710374...	3730
13	6.1	294.3000000000	8.3000000000	-516903.804237...	-315975.710374...	-505356.798854...	-325975.710374...	3731
14	6.1	295.3000000000	27.8000000000	-534224.312313...	-325975.710374...	-522677.306929...	-335975.710374...	3504

2.3.4. Summarise the Intersected fire point by HEX_ID

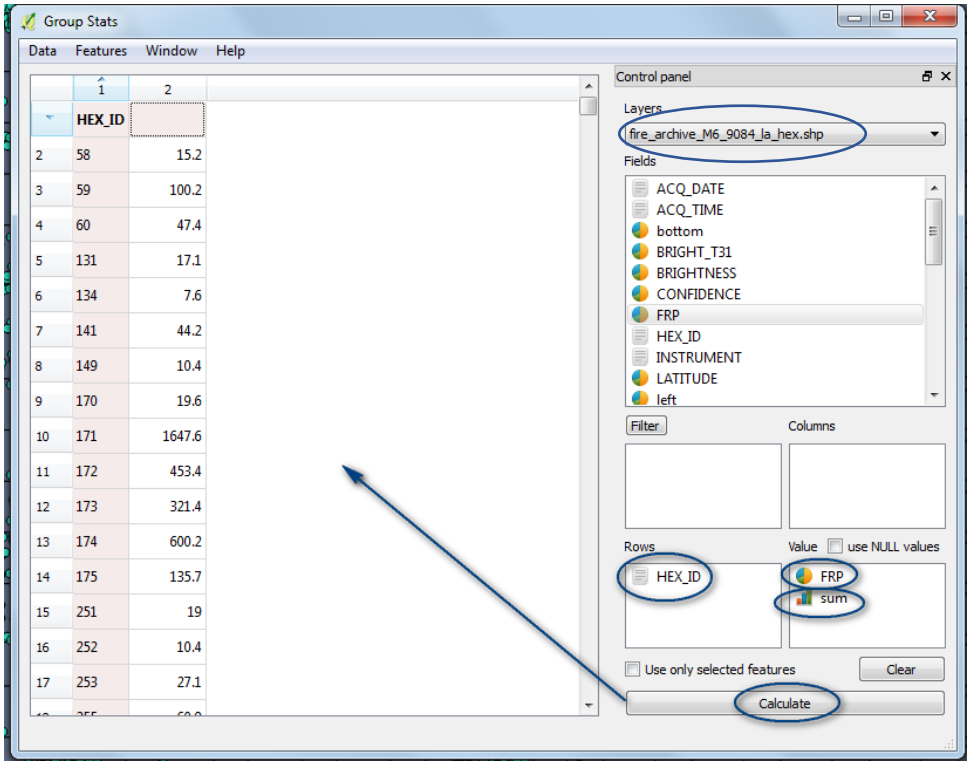
a. From the main menu click on **Plugins>>Manage and Install Plugins**
b. Search for and install the plugin **GroupStats**



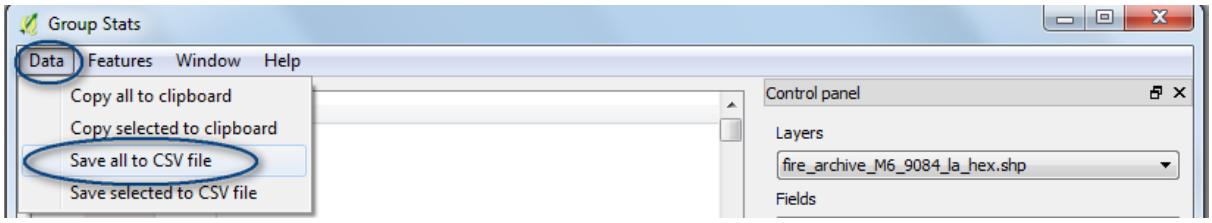
c. From the **Vector** menu click on **Group Stats>>GroupStats**



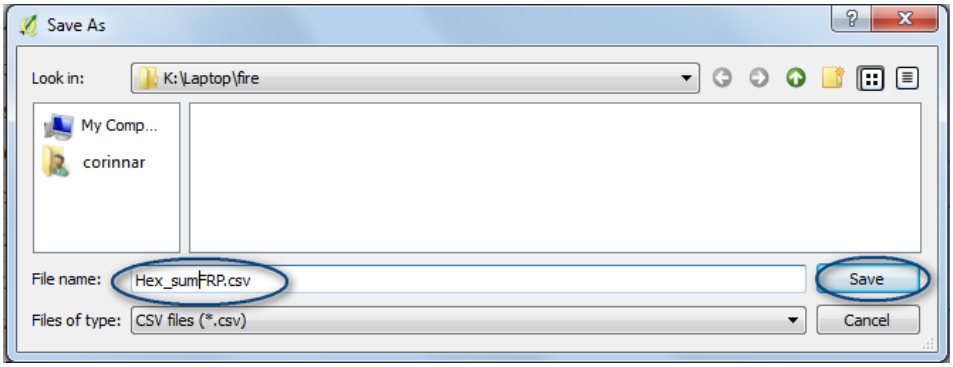
d. Select in the **Layers** box the shapefile resulting from the intersection(section 2.3.3)
e. **Drag HEX_ID into the row box**
f. Drag **FRP** and sum into the **Value** box
g. Click **Calculate** to generate a table showing **HEX_ID** and **sum of FRP** values



h. From the GroupStats menu click on **Data>>Save all to CSV file**

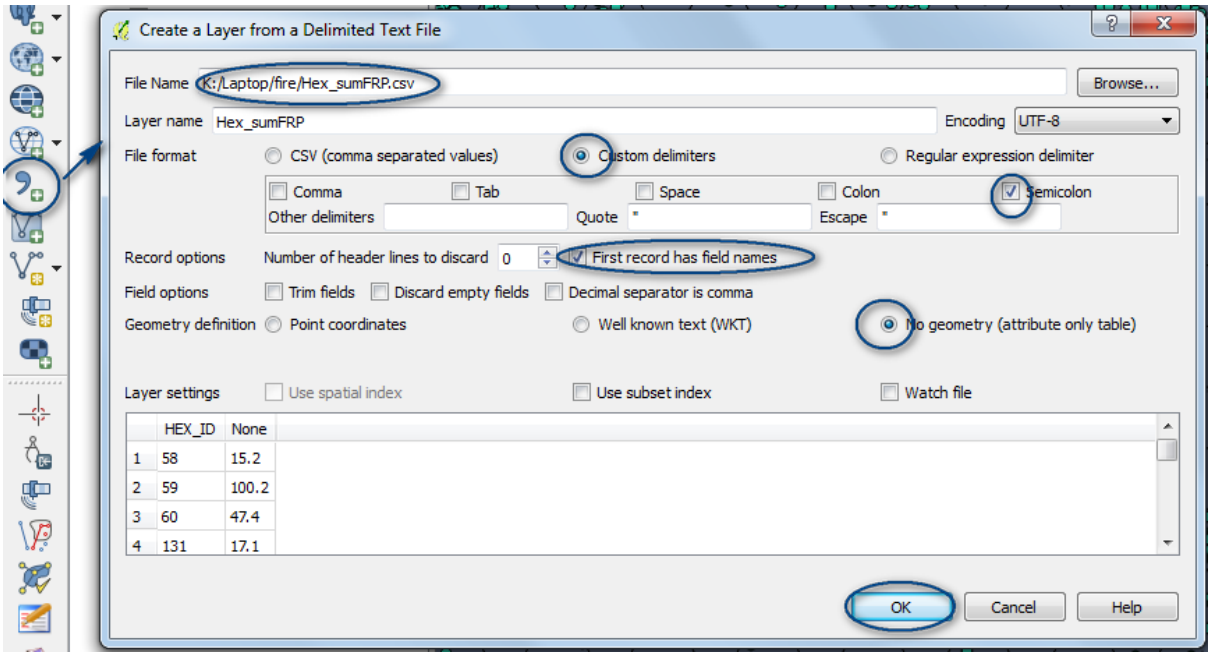


i. Navigate to an output folder and save the CSV file as **Hex_sumFRP.csv**



j. Close **GroupStats**

k. Click on the **Add delimited text button** to add **Hex_sumFRP.csv** to your QGIS project

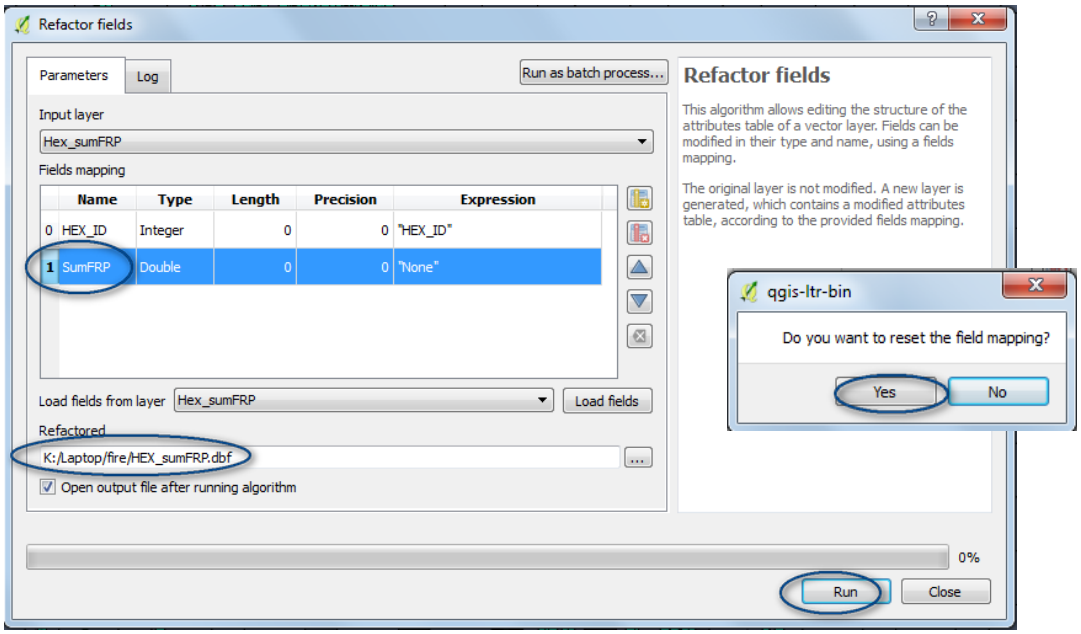


l. Change to **Custom delimiter** and **Semicolon**

m. Tick **First record has field names** and select **geometry (attribute only table)**

n. **Click OK**

o. When you open the CSV file you will note that the sum of the FRP values have a fieldname of None. To change this search for **Refactor fields** in the processing toolbox



p. Change the input layer to the Hex_sumFRP csv file. Click **Yes** to the popup **Do you want to reset the field mappings?**

q. Change the Name **None** to sumFRP

r. Navigate to an output folder and save the CSV file as **Hex_sumFRP.dbf**

s. Click **Run**

2.3.5. Join the summarized fire data to the hexagon polygons

a. Right-click on the hexagons polygon i.e. in this example, **hexagons_10km2.shp** and click **properties**

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

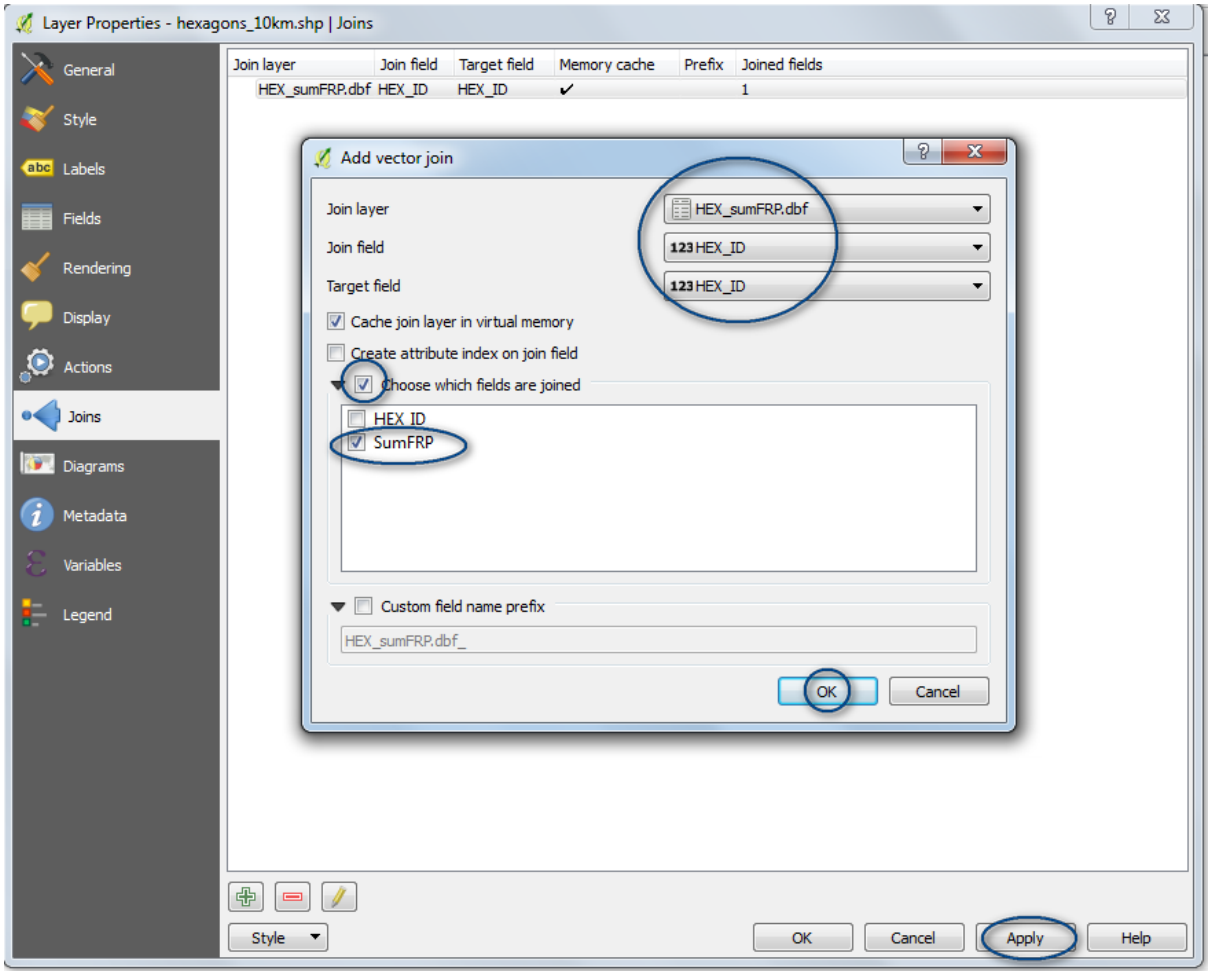
c. Click on the **+** button to add a join

d. Select the **Hex_sumFRP.dbf** as the Join Layer

e. Pick **HEX_ID** for both the **Join field** and **Target Field**

f. Tick **Chose which fields are joined** and tick **SumFRP**

g. Click **OK** and then **Apply**



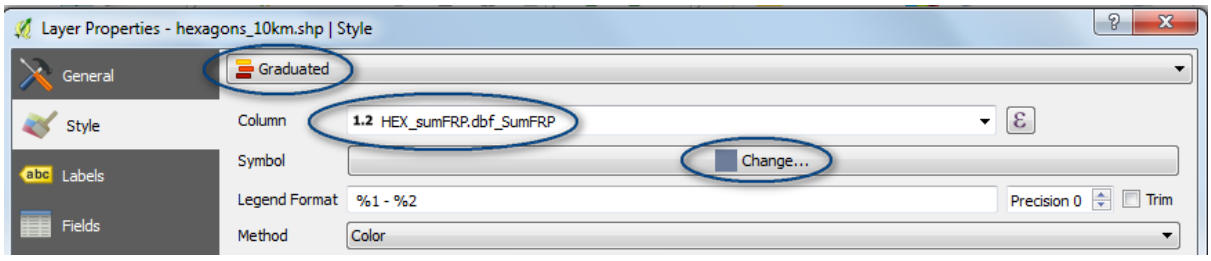
h. Right click the layer "Hexagon _10km2" and select Properties

i. In the left hand column of the **Layer Properties** window click on **Style**

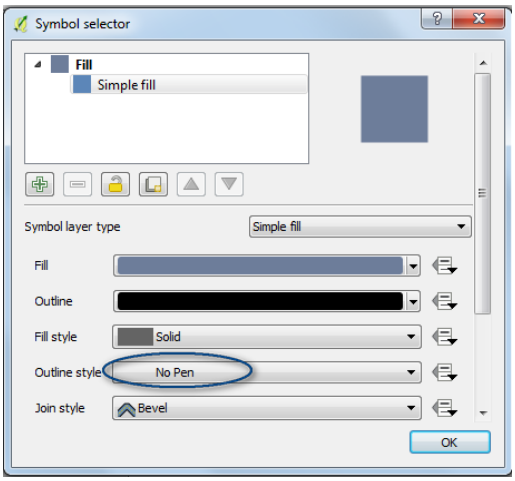
j. Change the from Single symbol to **Graduated**

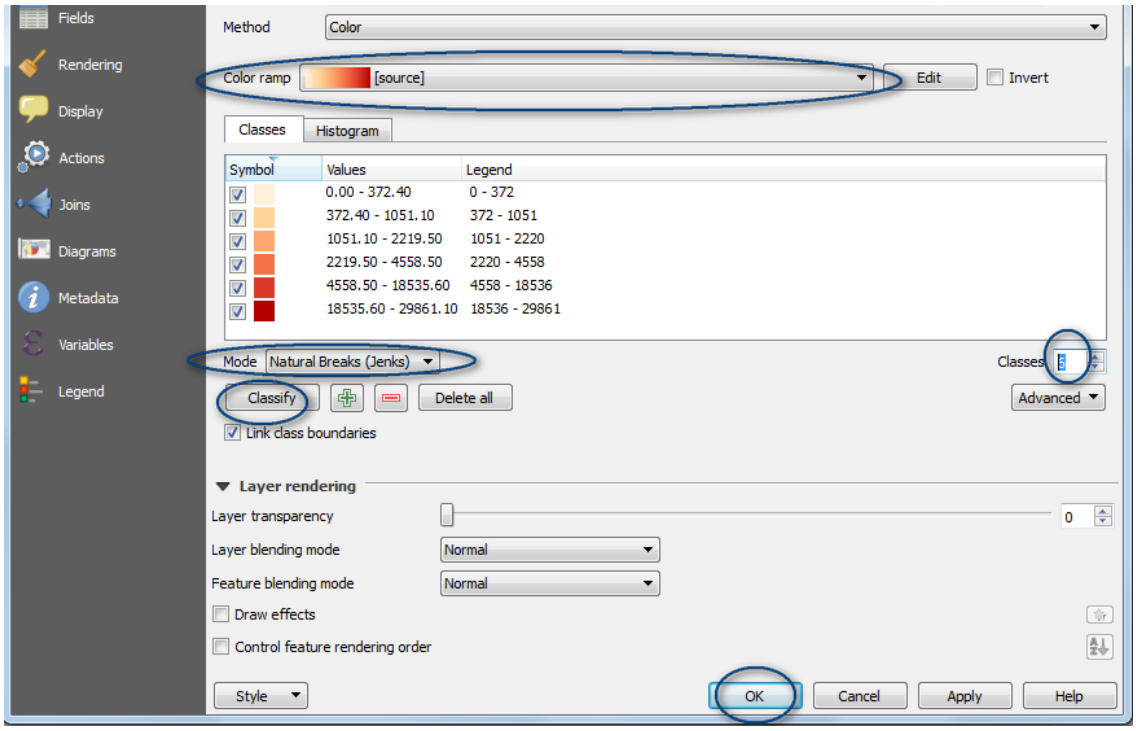
k. Select the **Column** (to use to shade the hexagons) **HEX_sumFRP.dfb_SumFRP**

l. Change the symbol by clicking on **Change**



m. Change the outline style to **No Pen** and click on **OK** to close the symbol selector. This removes the black outlines from all the hexagons
n. Select an orange colour ramp to shade the hexagons
o. Change the number of classes to **6**
p. Change the classification method to **Natural Breaks (Jenks)**
q. Click **Classify**
r. Click **OK**





The final map show the sum of FRP values in each 10km2 hexagon representing both intensity and density of fires. The resultant data have been displayed using natural breaks (jenks) classification method.