

Segmentation Guide using open source resources

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This guide aims to give you a step by step guidance to digitize tree cover in google earth using only open source programs.

You will need to download:

- QGIS
- Orfeo

Table 1: Symbols to make your reading easier

Symbol	Meaning
	Information about our process/data
	Observation about step
	Useful web link

1) Download QGIS and get familiar with the program.

- 1.1) Download QGIS from: <http://www.qgis.org/en/site/forusers/download.html>



This Guide was developed with the version QGIS version 2.16.3 (windows) / 2.18.0 (mac). If you are using a different version, you should be aware that you will find different layouts within the program that might make it harder to follow this protocol.

- 1.2) Get familiar to QGIS.

If you are not familiar with the program, we recommend you to spend some time just “playing” with the program or watching some YouTube videos about it.

- <https://www.youtube.com/watch?v=aLmMovuydqI>
- https://www.youtube.com/watch?v=OtVpOzLA_NM
- <http://docs.qgis.org/2.0/pdf/>
- <http://qgis.spatialthoughts.com/2012/02/tutorial-styling-vector-data-in-qgis.html>
- http://www.qgistutorials.com/en/docs/making_a_map.html
- <http://qgis.spatialthoughts.com/2012/02/tutorial-styling-vector-data-in-qgis.html>

2) Installing Plugins and Toolboxes needed to perform the classification with this guide.

a. Install and open “QuickMapServices” plugin:

Go to Plugins > Manage Plugins > type QuickMapServices > **Install** QuickMapServices plugin.

Go to Web > QuickMapServices > Settings > More services > **Get contributed pack**

Open the google satellite image:

Web > QuickMapServices > Google > Google satellite.

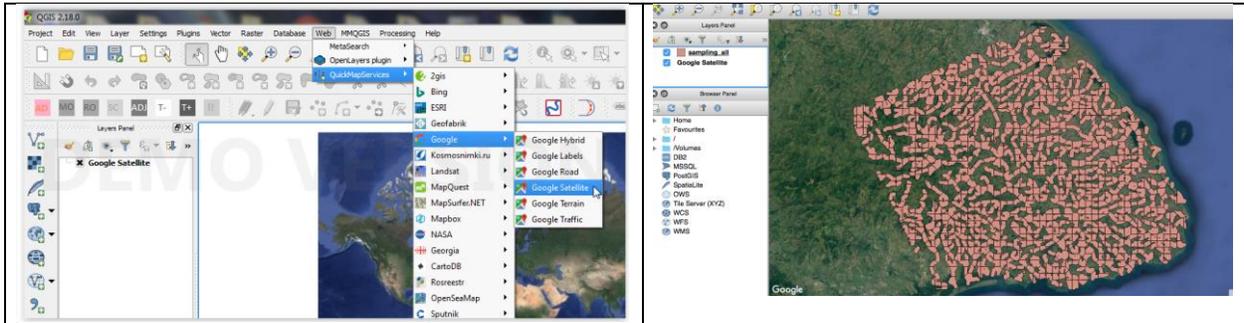


Figure 1: step 2.a)

b. Install “Image Footprint” plugin:

- Go to Plugins > Manage Plugins > Settings
- Mark the box “Show also experimental plugins”

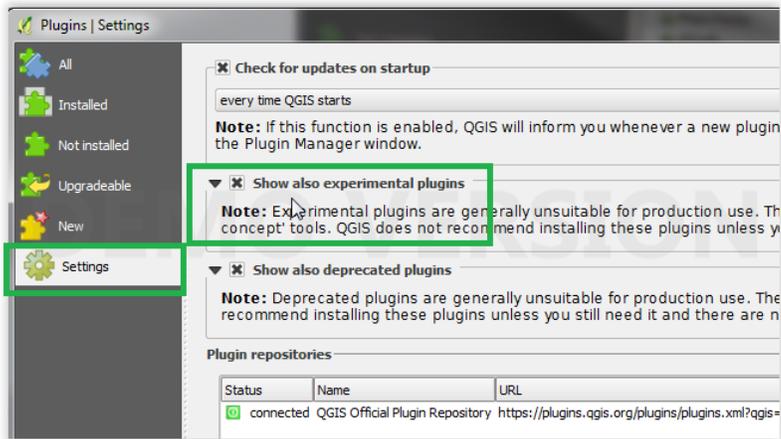


Figure 2: step 2.b)

- Go to Plugins > Manage Plugins > type **Image Footprint** >
- **Install** “Image Footprint” plugin.
- Go to **Web > Plugins** and verify it was installed.

c. Download Orfeo

Orfeo is an open source tool to help users to process remote sensing imagery.

To install it go to: <https://www.orfeo-toolbox.org/>

Then: Download > Windows > 64 bits



If Orfeo tool box does not load into QGIS When we tried to install Orfeo, you would try to place Orfeo source files in a different location from the default location. It seems to be a bug in QGIS but by following the instructions in figure 3 normally fix the problem. Nevertheless, one of us had to install and reinstall QGIS to get the Orfeo toolbox.

- Unzip and copy OTB-5.6.1 -win64 folder to **C:\qgistools** after creating it.
- Open QGIS > Processing > options > open provider tab > Open Orfeo tool box (image analysis) > check “Activate” >
- Set OTB folder values as:
 - o OTB applications folder = **C:\qgistools\OTB-5.6.1-win64\lib\otb\applications**
 - o OTB command line tools folder = **C:\qgistools\OTB-5.6.1-win64\bin**

GETTING READY TO USE ORFEO TOOL BOX !

IF ORFEO TOOL BOX DOES NOT LOAD INTO QGIS
THE DEFAULT QGIS FOLDER LOCATION FOR THE ORFEO TOOL BOX NOT WORKING,
THE FOLLOWING FIXES THIS ISSUE:

Orfeo tool box

1. Download Orfeo tool box
 - o <https://www.orfeo-toolbox.org/>
 - o 5.6.1 for 64bit was tested.
2. Unzip and copy OTB-5.6.1-win64 folder to C:\qgistools\. Create qgistools folder under C:\.
3. Open QGIS > Processing > options > open provider tab > Open Orfeo tool box(image analysis) > checked “Activate”

C:\qgistools\
> Set OTB application folder : OTB-5.6.1-win64\lib\otb\applications
> Set OTB application folder : OTB-5.6.1-win64\bin
4. Restart QGIS > OTB will be appears in Processing Toolbox.

Processing Toolbox

Search

- > GDAL [48 geosalgorithms]
- > GRASS GIS 7 commands [314 geosalgorithms]
- > Mapbox [0 geosalgorithms]
- > Orfeo Toolbox (Image analysis) [99 geosalgorithms]
 - > Calibration
 - > Feature Extraction
 - > Geometry
 - > Image Filtering
 - > Image Manipulation
 - > Learning
 - > Miscellaneous
 - > Segmentation
 - > Stereo
 - > Vector Data Manipulation

Figure 3



Useful web explanation: StackExchange pertinent Q & A
<http://gis.stackexchange.com/questions/215153/orfeo-toolbox-for-qgis-not-activating-after-trying-several-suggestions>

3) Creating your Area of Interest (AOI) Polygons.

Before you start to go through this guide you should make sure you have the area of interest polygons you want to classify. It is important to notice that your data should be in **.shp** or **.kml** format.



Examples of polygons include cadastral data that have properties boundaries, or riparian corridors that should be easy to create by doing a buffer around the riparian strips.

http://www.qgistutorials.com/en/docs/performing_spatial_queries.html



The examples in this guide were made over the data from the “**Azuero Research Project**” that takes place in Panama. The following figure illustrates how the data looks like. The Azuero’s AOI polygons were riparian corridors.



Figure 4: Data exemplification: Azuero Project data

a. Creating a Grid in QGIS for AOI

3.1) Open QGIS and add the AOI polygons.

3.1.1) Open your AOI polygons layer:

Go to Layer > add layer > add vector layer > choose your file and click open

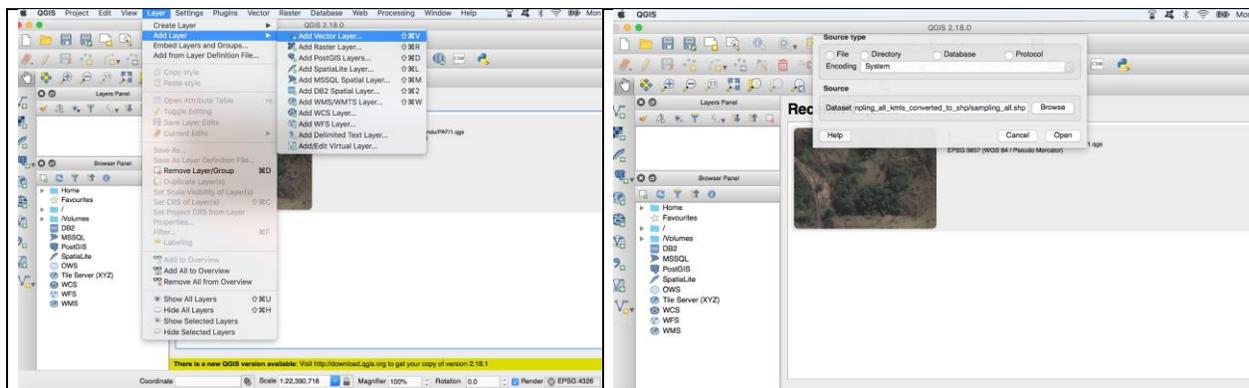


Figure 5: step 3.1.2

3.1.2) Create a Grid Vector

Go to Vector tab > Research Tools > Vector Grid.

- Under “Grid Extent” Click the “...” button in the right and select “Use layer/canvas extent” > select your AOI polygons.
- Under “X spacing”: Choose X values to match your AOI coverage.
- Under “Y spacing”: Choose Y values to match your AOI coverage.



In our case we used: **X spacing = 0.025** **Y spacing = 0.01**
(you may want to try this setting first).

But note that these X and Y values may require several attempts to match unique AOI coverage.

- Under “grid type” choose “Output grid as polygons”
- Under “Grid” > “Save to file” > name accordingly, e.g. “New Grid”
- you can check the box/click the “open output file after running algorithm”
- press run

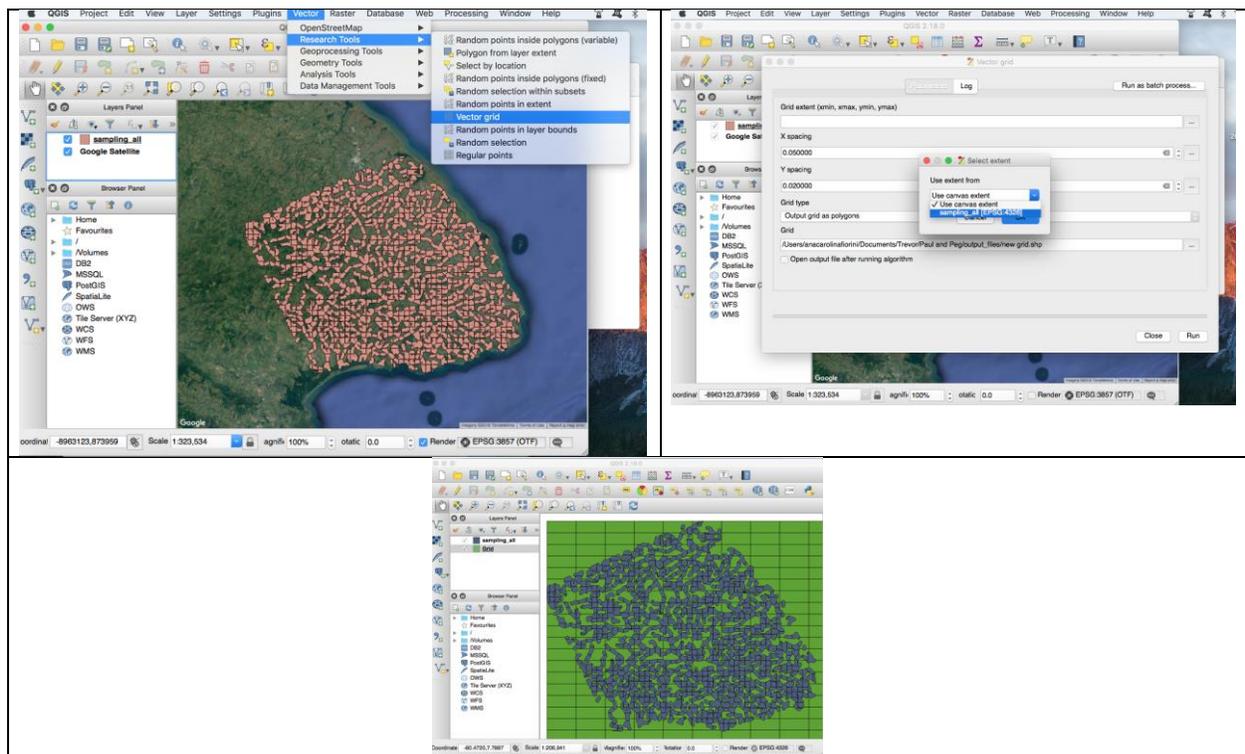


Figure 6: step 3.1.4

3.1.3) Select the grid polygons that contain AOI polygons.

- Go to Vector > Research Tools > **Select by location**
- In the “Select by location window”:
 - **Layer to select from** = your “New Grid”
 - **Additional layer (intersection layer)** = your AOI Polygons
 - Click the box of “**intersects**” under “Geometric predicate”
 - Press run.

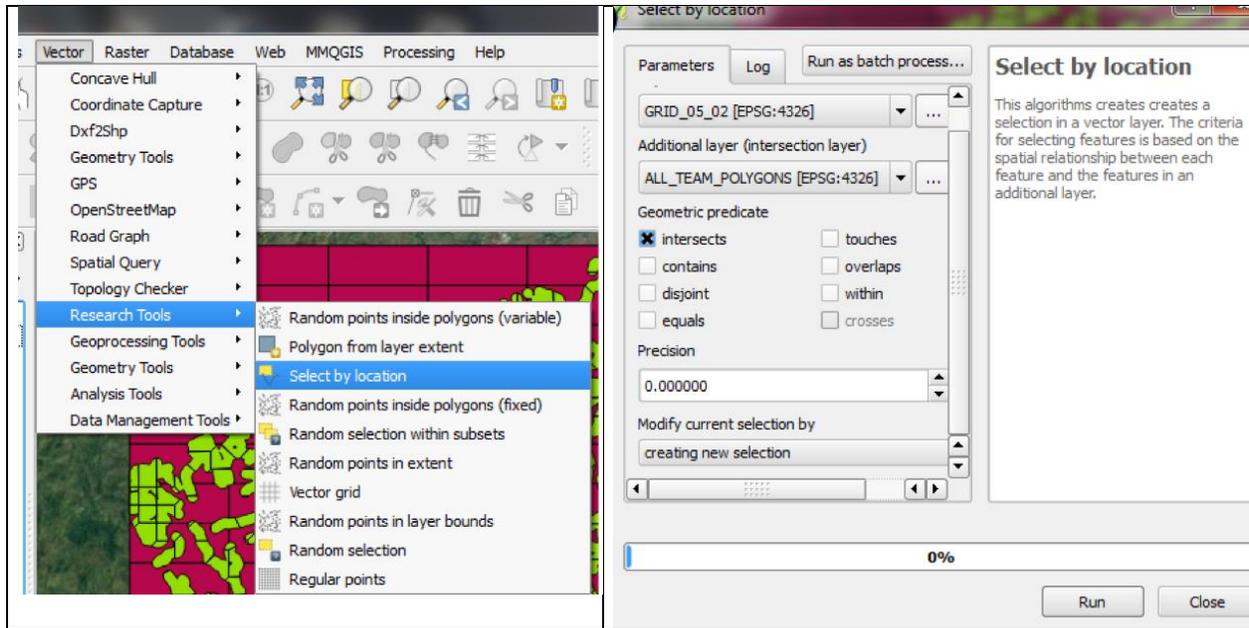


Figure 7: step 3.1.5

3.1.4) You will now reduce the number of polygons using New Grid and AOI polygons.

1) Open the attribute table of “New Grid”.

You will see the New Grid records intersecting the AOI are now selected.

2) Click  the **Invert selection** button.

Right Click on the New Grid > **Toggle Editing** 

3)  **Delete selected features**

4)  Click the **Toggle Editing** button

5) **Save** the New Grid with now specific grid coverage for the AOI.

1)

GRID_05_02 :: Features total: 190, filtered: 190, selected: 140

	id	xmin	xmax	ymin
1	0	-80.4625826024...	Invert selection (Ctrl+R)	7.755694115
2	1	-80.4125826024...	-80.3625826024...	7.755694115
3	2	-80.3625826024...	-80.3125826024...	7.755694115
4	3	-80.3125826024...	-80.2625826024...	7.755694115
5	4	-80.2625826024...	-80.2125826024...	7.755694115
6	5	-80.2125826024...	-80.1625826024...	7.755694115
7	6	-80.1625826024...	-80.1125826024...	7.755694115

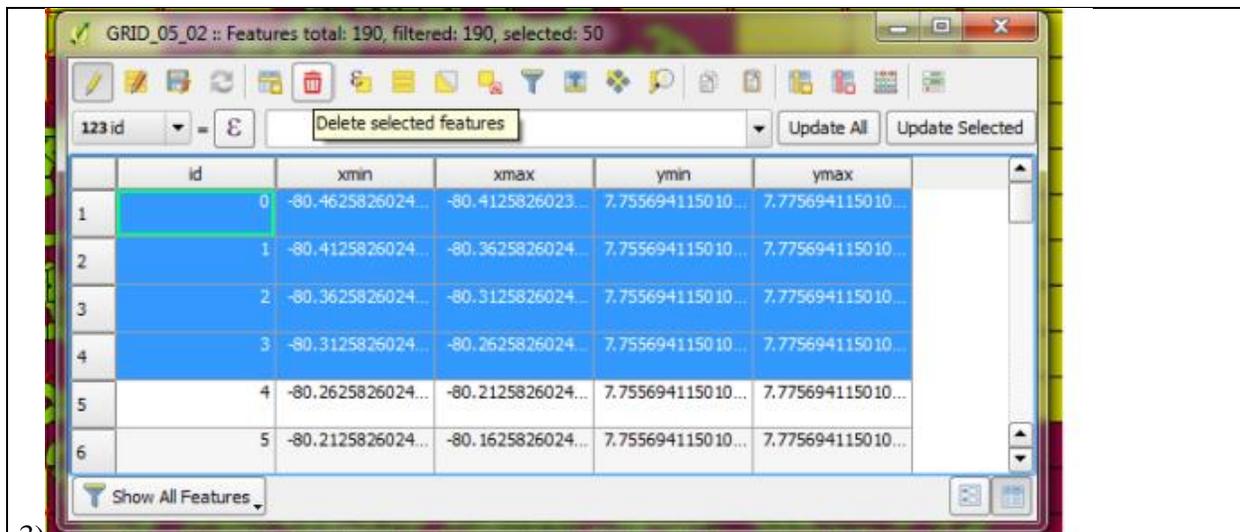
Show All Features

2)

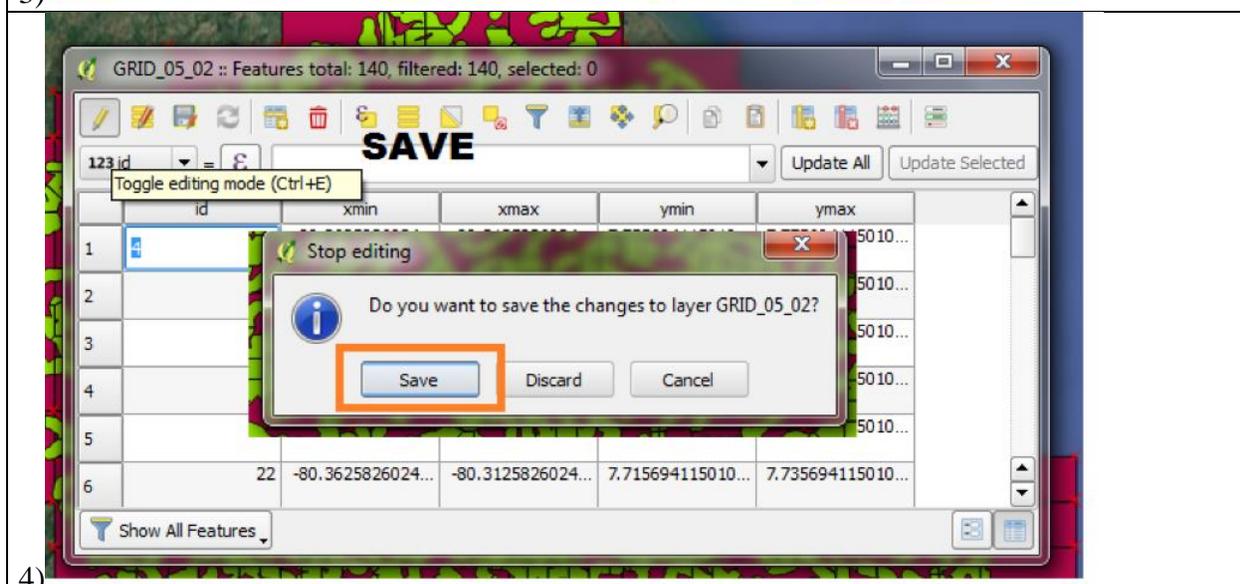
Grid :: Features total: 190, filtered: 190, selected: 50

	id	xmin	xmax	ymin	ymax
1	0	-80.4625826...	-80.4125826...	7.755694115...	7.775694115...
2	1	-80.4125826...	-80.3625826...	7.755694115...	7.775694115...
3	2	-80.3625826...	-80.3125826...	7.755694115...	7.775694115...
4	3	-80.3125826...	-80.2625826...	7.755694115...	7.775694115...
5	4	-80.2625826...	-80.2125826...	7.755694115...	7.775694115...
6	5	-80.2125826...	-80.1625826...	7.755694115...	7.775694115...
7	6	-80.1625826...	-80.1125826...	7.755694115...	7.775694115...
8	7	-80.1125826...	-80.0625826...	7.755694115...	7.775694115...
9	8	-80.0625826...	-80.0125826...	7.755694115...	7.775694115...
10	9	-80.0125826...	-79.9625826...	7.755694115...	7.775694115...
11	10	-80.4625826...	-80.4125826...	7.735694115...	7.755694115...
12	11	-80.4125826...	-80.3625826...	7.735694115...	7.755694115...
13	12	-80.3625826...	-80.3125826...	7.735694115...	7.755694115...
14	13	-80.3125826...	-80.2625826...	7.735694115...	7.755694115...
15	14	-80.2625826...	-80.2125826...	7.735694115...	7.755694115...
16	15	-80.2125826...	-80.1625826...	7.735694115...	7.755694115...
17	16	-80.1625826...	-80.1125826...	7.735694115...	7.755694115...

Show All Features



3)



4)

Figure 8: step 3.1.6

3.1.5) Depending on the size of your AOI, you will divide the output grid file in several files to avoid QGIS crashing.

1) Use the “**Select Features by area or single click**” button to select the isolated portions of the grid.



2) Open the attribute table of “New Grid”. You will see that the New Grid records intersecting the AOI are now selected.



3) Click the “Invert selection” button.

4) Right Click on the New Grid > Toggle Editing





Delete selected features



5) Click the “Toggle Editing” button

Save the New Grid with the isolated portions of the grid AOI with a new name.

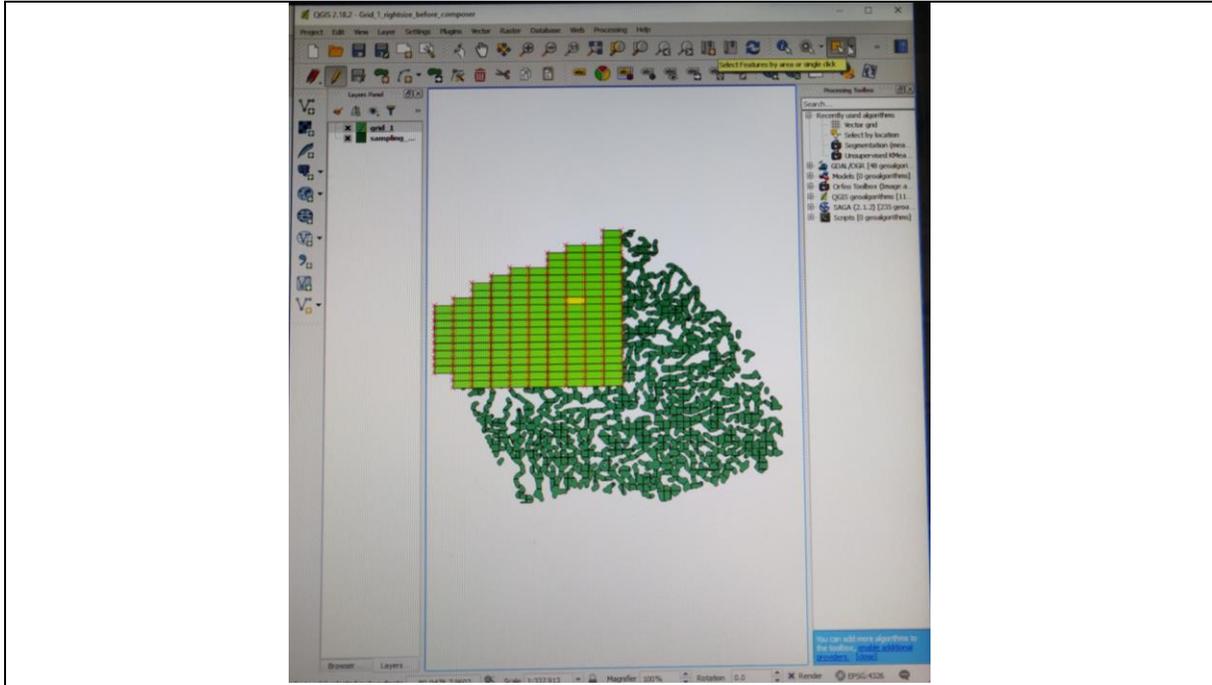


Figure 9: step 3.1.7

b. Clipping WMS (Google Satellite in our case) in QGIS using a Grid

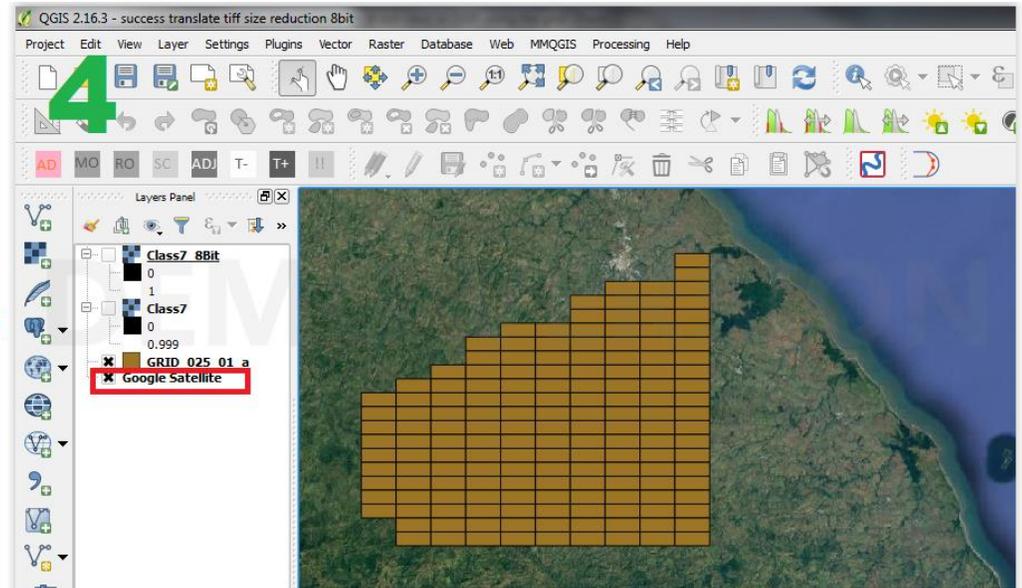


Useful web explanation: GIS StackExchange pertinent Q & A

<http://gis.stackexchange.com/questions/213054/qgis-export-save-as-image-automate-with-python>

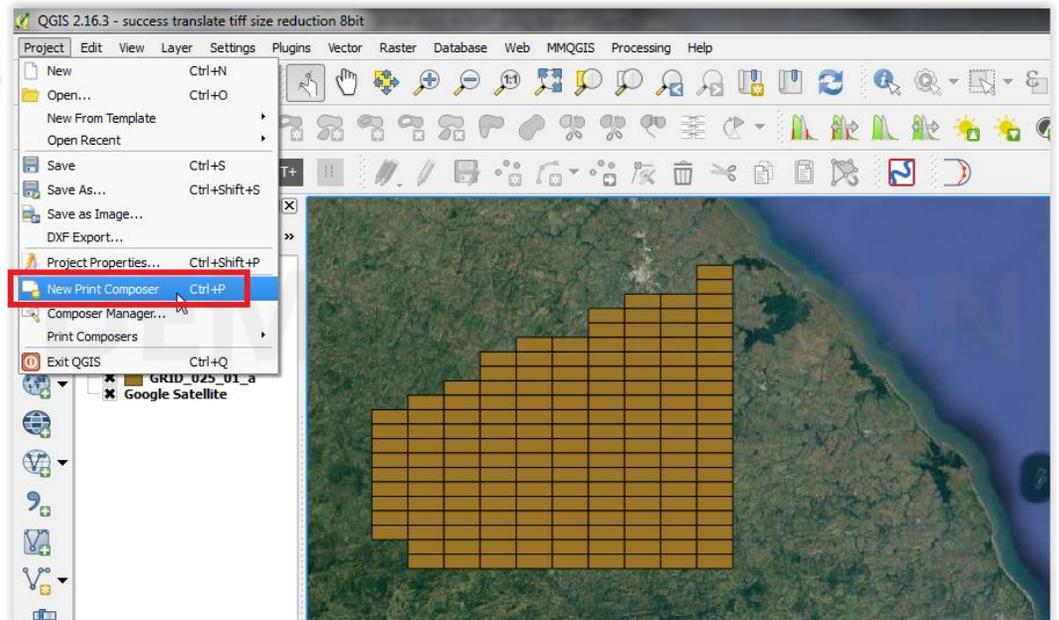
4.1.4. Add the Grid shp > right click on it > “Zoom to Layer” :

**GOOGLE SAT IS
ADDED ALONG
WITH GRID**



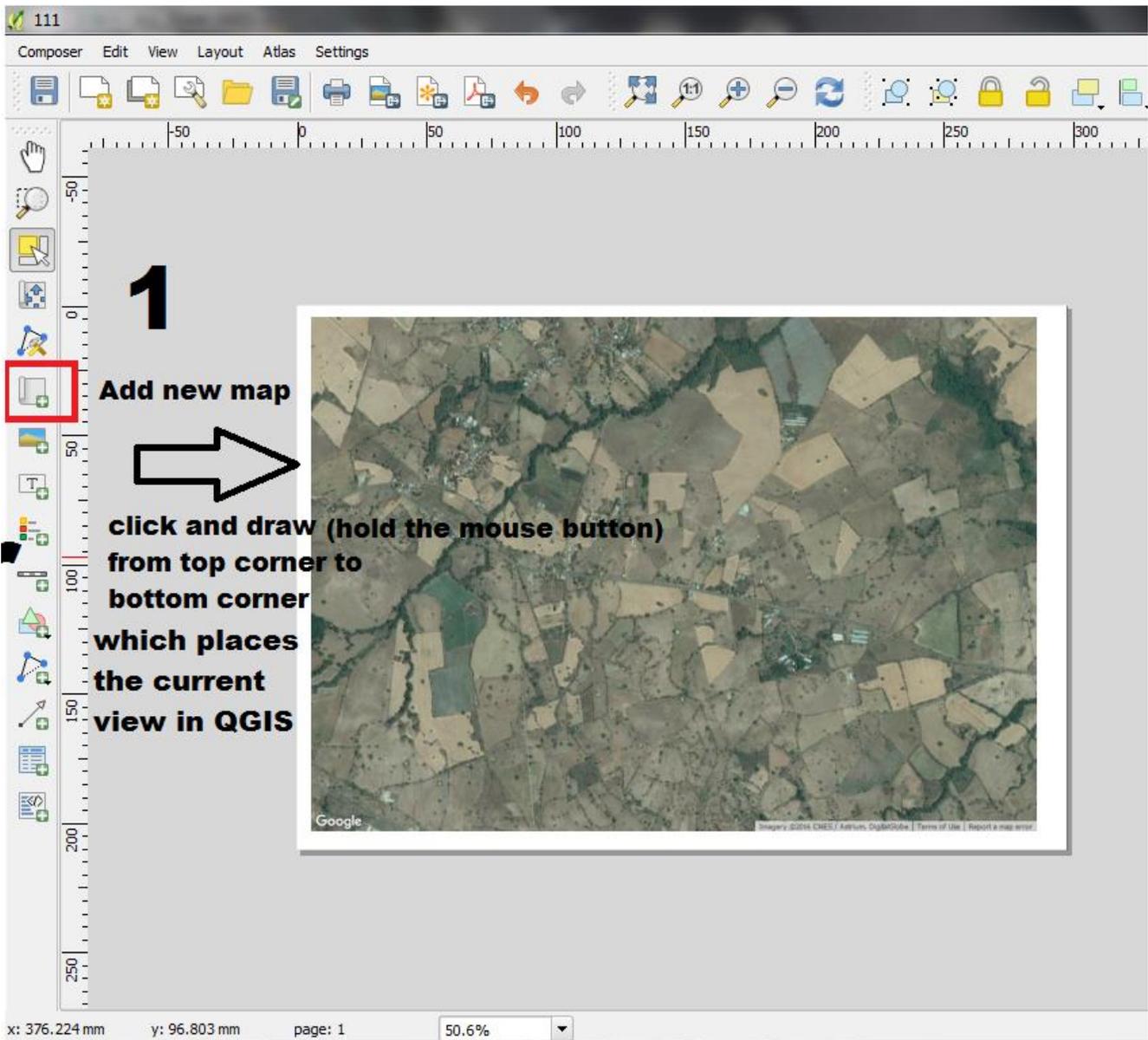
4.1.5. Go to Project > “New Print Composer”:

5



4.2)
clipping
WMS in
QGIS using
a grid (**Part I** Print Composer)

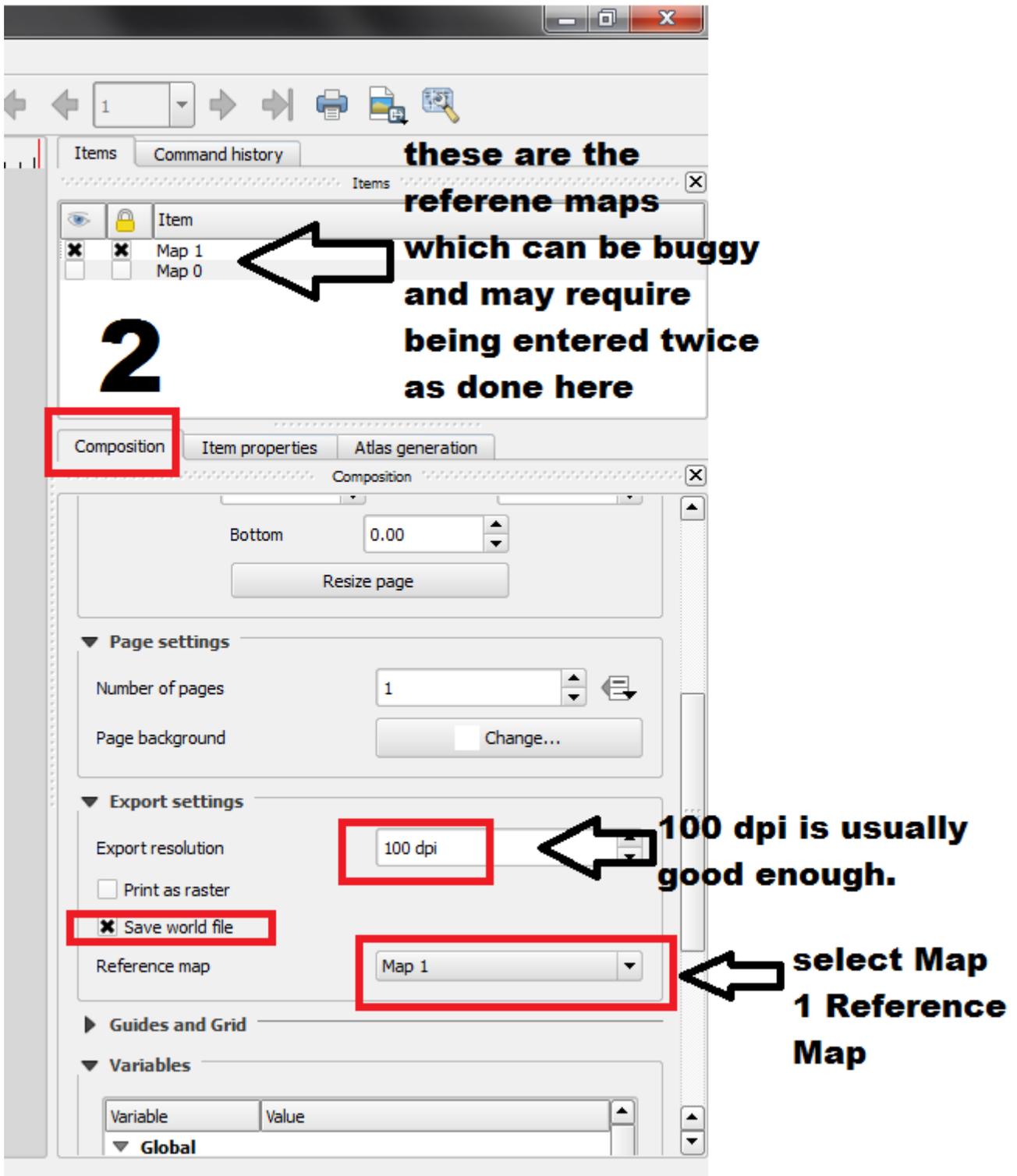
4.2.1. Click “Add new map” button then left click / hold mouse button and draw (drag) from top left corner to bottom right corner. This places the current QGIS view into Print Composer.



It is important that you make sure all the white area is covered in this step. You will feel that when you are moving the image it “grips” to the total canvas of the white area.

<http://imgur.com/a/HAYhv>

4.2.2. To the far right under “Items” tab check both boxes for reference map “Map 0”.
 note if world files are not produced another “Add new map” step 1 needs to be done and then checking both of “Map 1” boxes while deselecting “Map 0” boxes will usually fix this bug.
 Click on the “Composition” tab > 100 dpi > check box “Save world file” >
 Reference Map = Map 0 or Map 1 (depending on the world file bug).



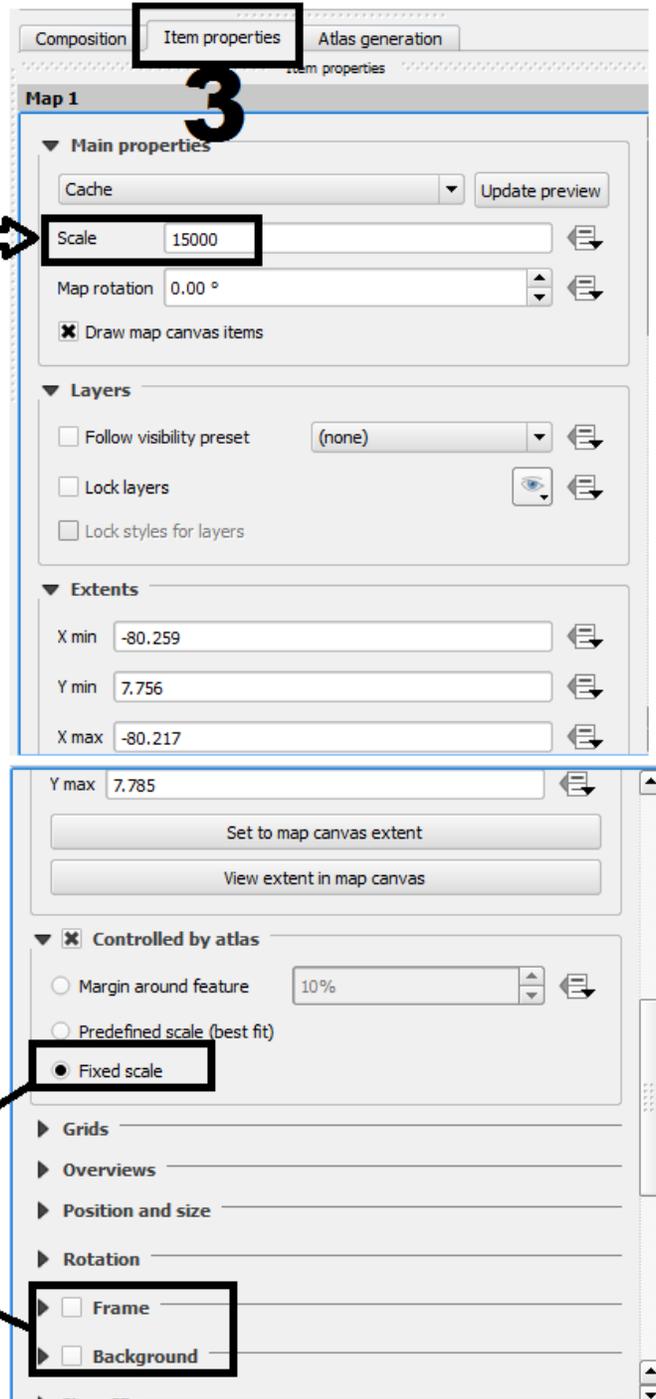
4.2.3. Go to “Item properties” tab > select appropriate scale for your project according to your AOI sizes.

- For Azuero Project we used 15000 as scale, if our suggestion of grid size worked for your project, you should try with 15000 too.

Check “Fixed Scale” and uncheck “Frame” and “Background”

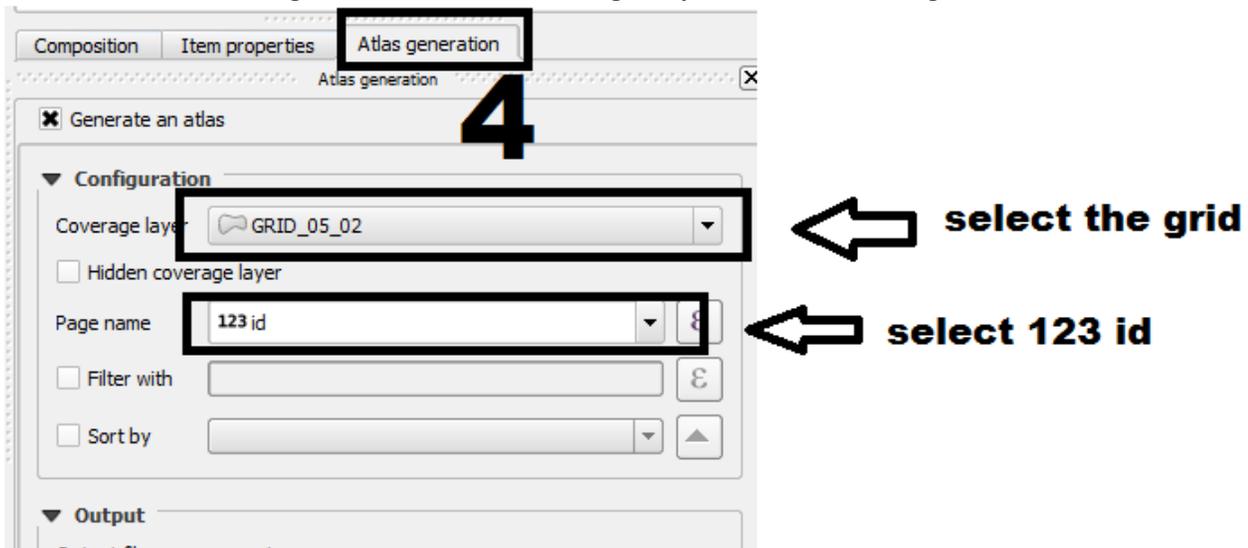
🧠 You will be able to click “fixed scale” after the step 4.2.4

15000 scale works best for the Azuero Project's AOI size. This will need adjustment depending on other AOI's sizes.



Default settings are mostly all good here except for Fixed Scale needs to be selected and Frame and Background unchecked.

4.2.4. Go to “Atlas generation” tab > Coverage Layer = the Grid > Page name = 123 id



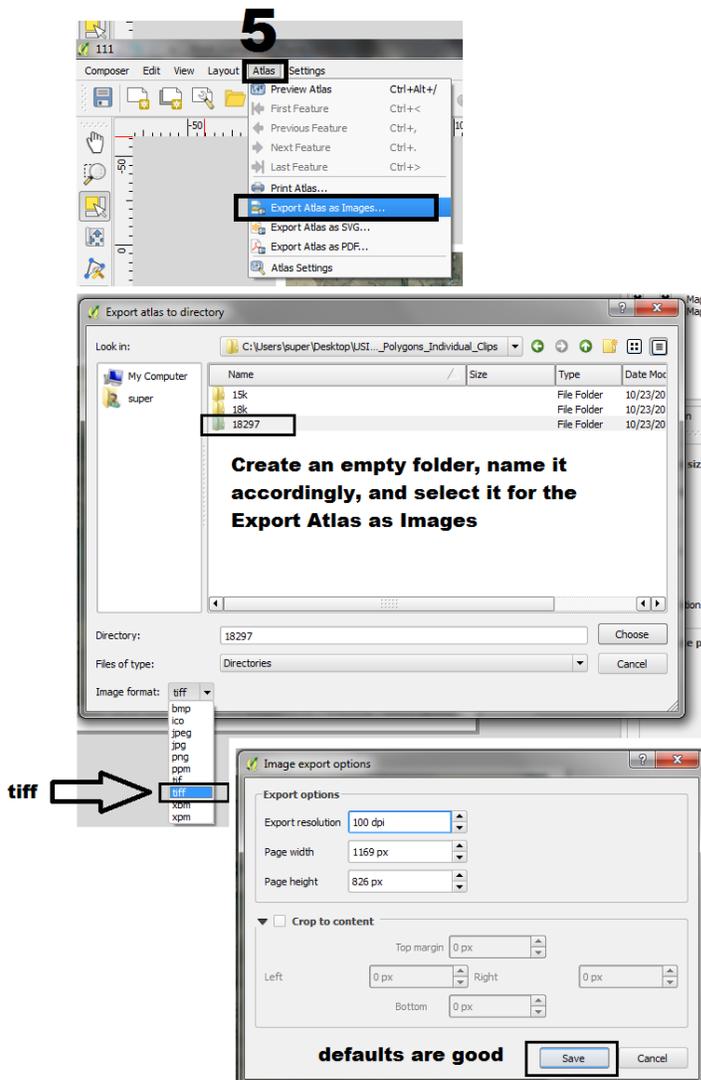
4.2.5. At the top left tabs go to “Atlas” > Export Atlas as Images...

For **Window users:** go to “Atlas” > Export Atlas as Images... Create an empty folder named accordingly and select it for the Export > Image format = tiff > Image export options with default settings > click “Save”.

For **Mac users:** You just need to select “Atlas” > Export Atlas as Images ...has a bug and sometimes do not show the tiff option. In that case you will create an empty folder named accordingly, accept the default that will appear and click save. See the type of documents that show up and convert them to tiff using a web converter.



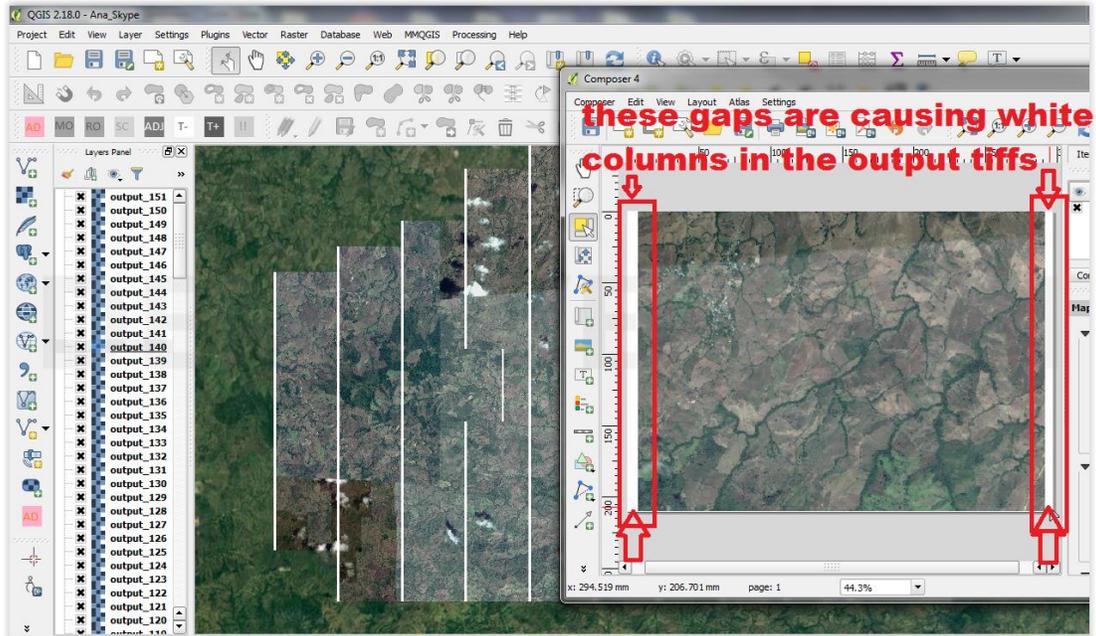
It is important to create a new folder once there will be many output files.



As the tiffs are exported check to make sure world files are coming in... if no world files are showing up, go back to the reference map step and try again.



if your output from this step has lines go to previous step and redo it fixing the gaps when adding a new map composer



c. Merging the Clips

- Go to Raster > Miscellaneous > Build Virtual Raster (Catalog)
Settings:
 - Check the following boxes:
 - “Choose input directory instead of files”
 - “Recurse subdirectories”
 - “Source No Data” = 0
 - “Target SRS” = Choose your AOI corresponding target
EPSG:4326 (in our case)

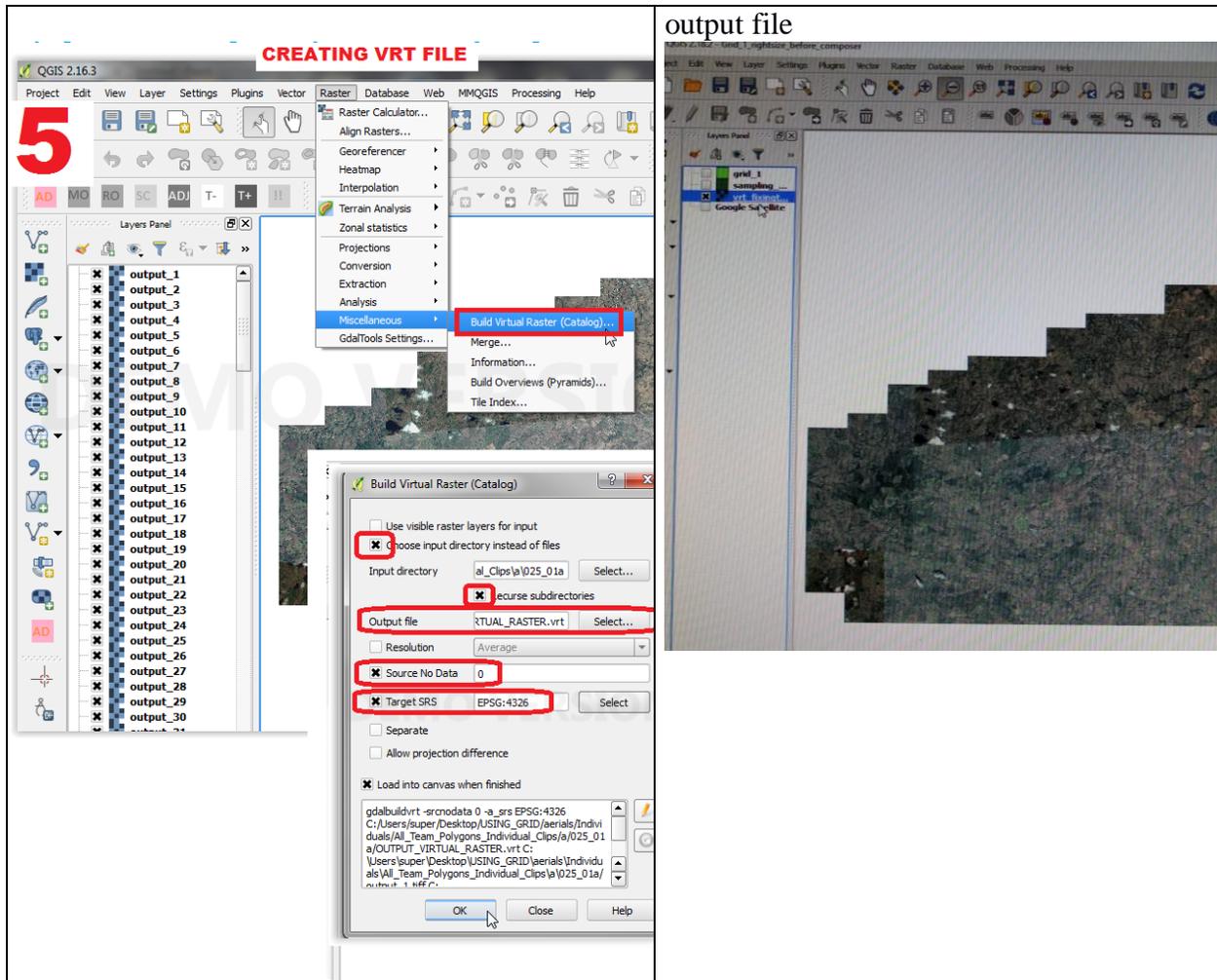


Figure 10: step %

Please see Q & A here: <http://gis.stackexchange.com/questions/25499/joining-several-raster-files-using-qgis> for further explanations on this step.

5. Separate each **.tiff** vintage from your **.vrt** file.

Look at the **.vrt** image that you have. Probably there are many Images resulting in the image composite image you have. If this is not the case, jump this step.

You need to separate the different images that are part of your **.vrt** image into separate **.tiff** using new **.shp** (outlines of the different vintage aerials).

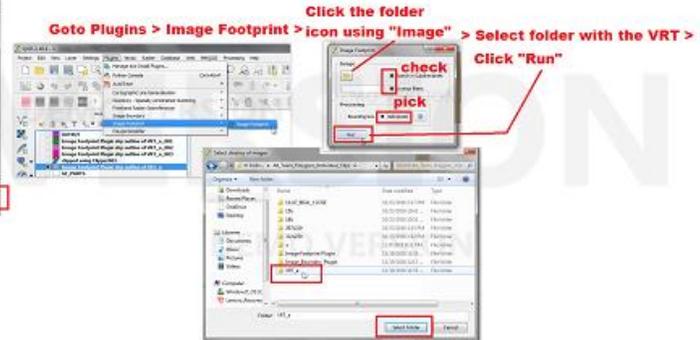
- <http://gis.stackexchange.com/questions/21774/aerial-vintage-changes-in-one-compiled-raster-how-to-split-it>

5.1.1. Create an outline polygon of the **.vrt**

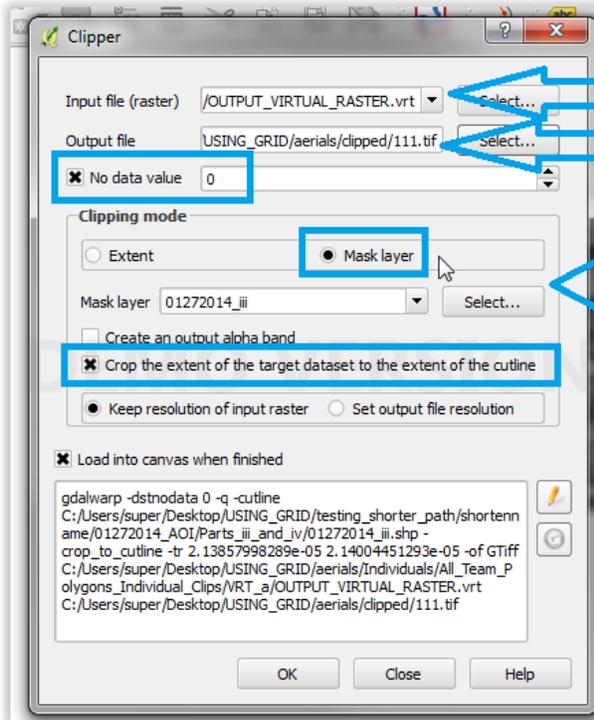
- Go to Plugins > Image Footprint > Click the folder icon “Image” > Select folder with the **.vrt** > Check both boxes > Pick “Valid pixels” > Click “Run”

8 IN LARGER AOI NEW SHP POLYGONS NEED TO BE CREATED OUTLINING THE AREAS WHERE GE IMAGERY CHANGES VINTAGES AND THEREBY REQUIRES US TO CHANGE OUR CLASSES TO MATCH THE TREE CANOPIES.

Goto Plugins > Manage and Install Plugins... > type "Image Footprint" into search > select it > click "Install Plugin"



- The output **.shp** will be a polygon around the **.VRT**. After Image Footprint finishes, look for a new polygon in table of contents named "Catalog.. the date.." This is the Footprint (polygon outline) of the whole **.VRT** Right Click on it > Save as > VRT_Footprint.



.VRT
new clip tiff
this is the polygon(s) created using Image Footprint and Split Features

5.1.2. Create shapefiles of the different images.

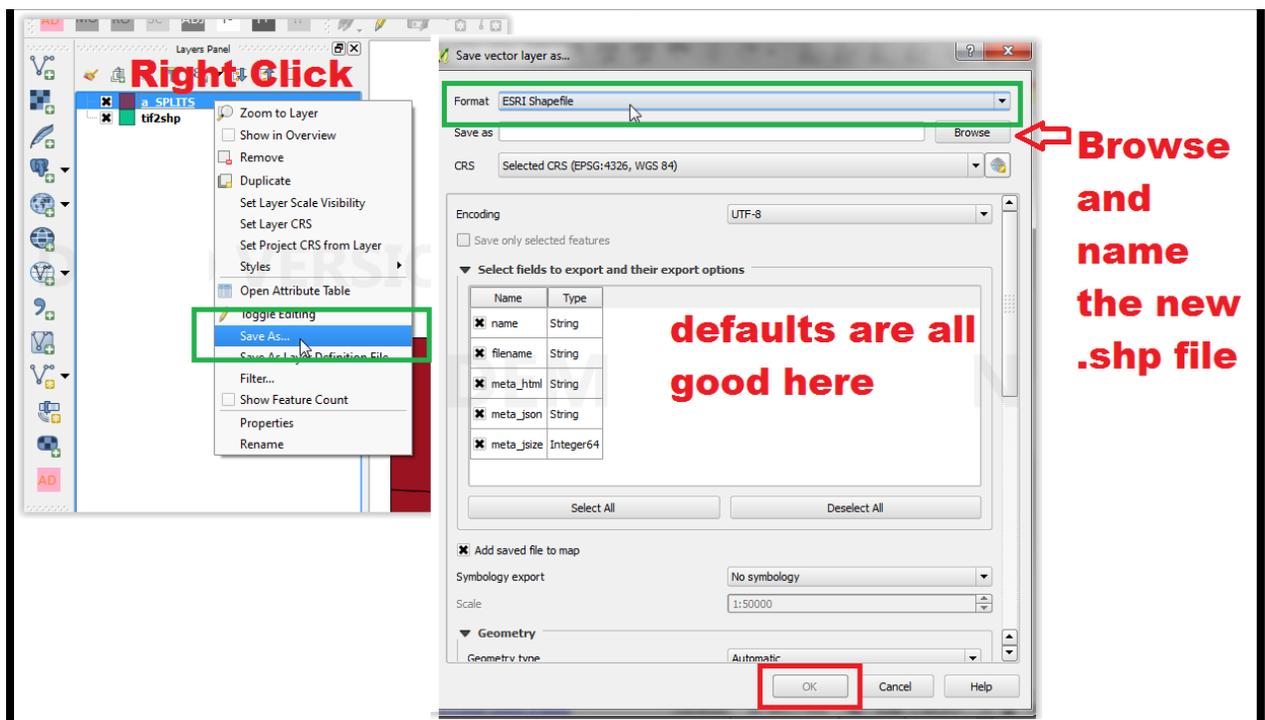
Go to edit > Footprint > Using the “**Split Features**” button (in Editor Toolbar) split the polygon into separate polygons based on each vintage.

Always to start and finish in a point outside the image. Click in the point of beginning, then click in the points that follow the vintage boundary, then double click outside.



- <http://gis.stackexchange.com/questions/46862/how-to-split-features-in-qgis>

Save these polygons by right click on it in the table of contents, later adding the dates of vintage to their names.

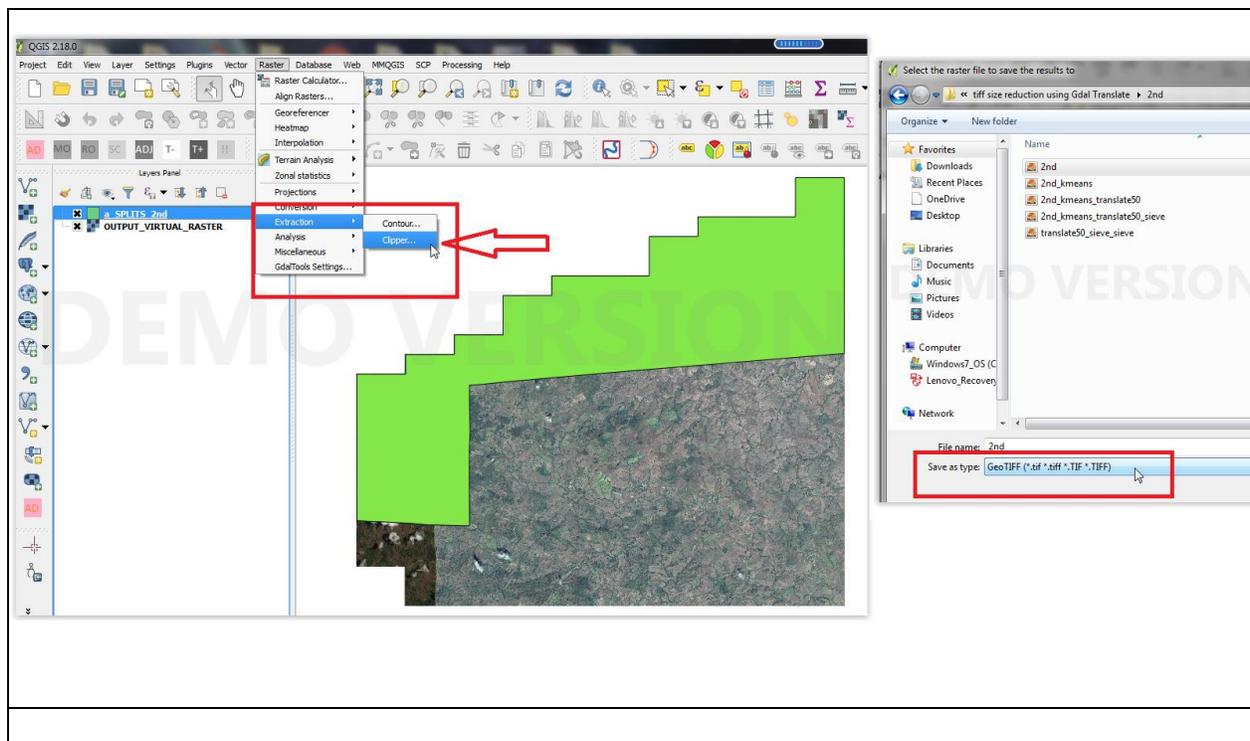


6. Use ORFEO to segment tree Canopies

In this step you will: Clip aeriels based on vintage, Orfeo Unsupervised KMeans, Orfeo output raster tiff size reduction, polygonizing tiff into shp, manual cleanup then into kml final

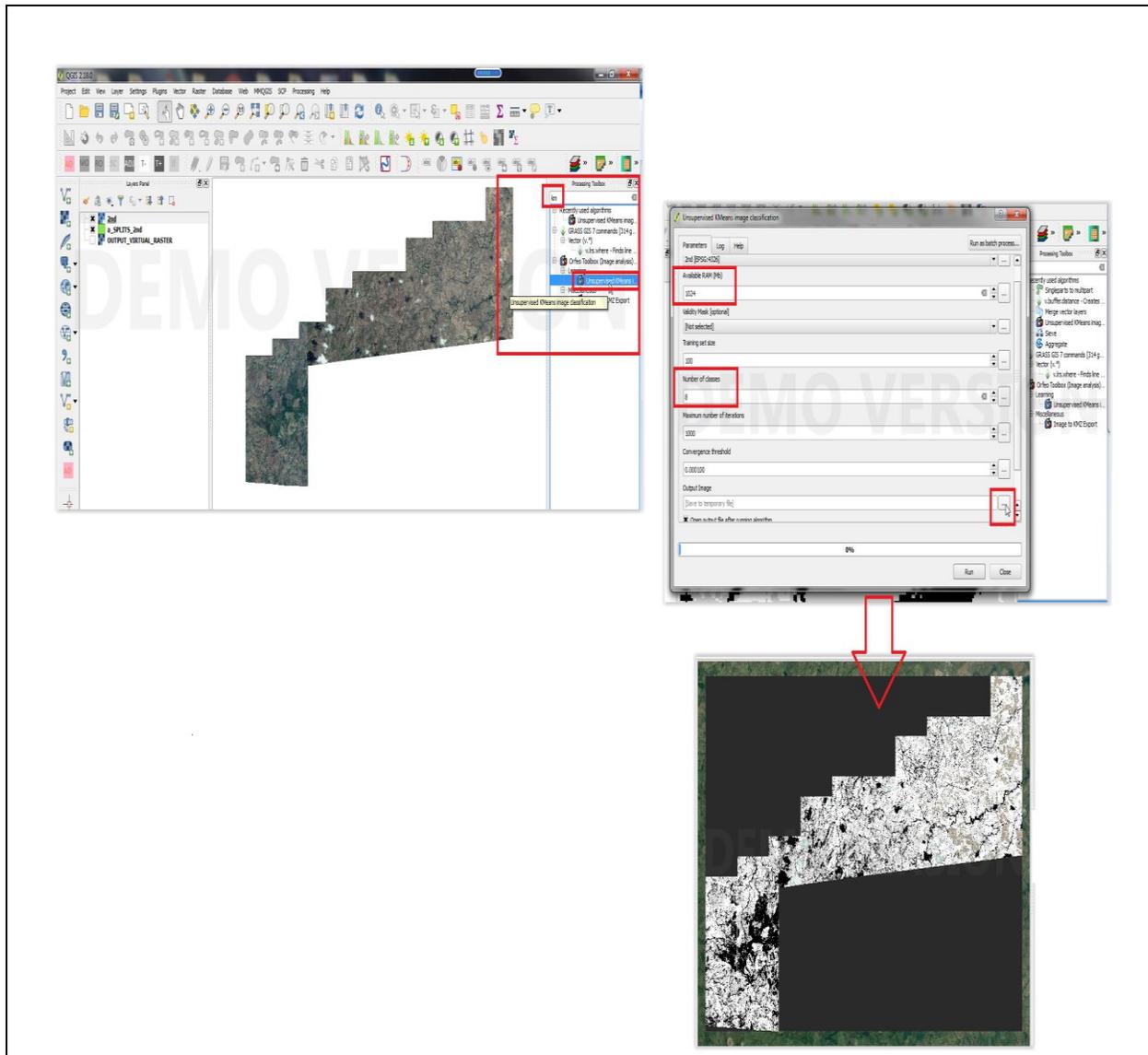
A) Clipping aeriels based on vintage

1. Open a new fresh QGIS session.
2. Add **.vrt** file
3. Add polygons outlining the aeriels based on vintage.
4. Raster > Extraction > Clipper >
5. File name: the vintage date (determined by Google Earth date)
6. Save as type **.tiff** output “vintage.tiff”



B) Orfeo classification using **Unsupervised KMeans**

1. Open processing toolbox
2. Type “km” into search
3. Double click **Unsupervised KMeans**
 - under: Available ram (Mb) = 1024
 - under: Number of classes = 8
 - Run as save output “vintage... kmeans.tiff”

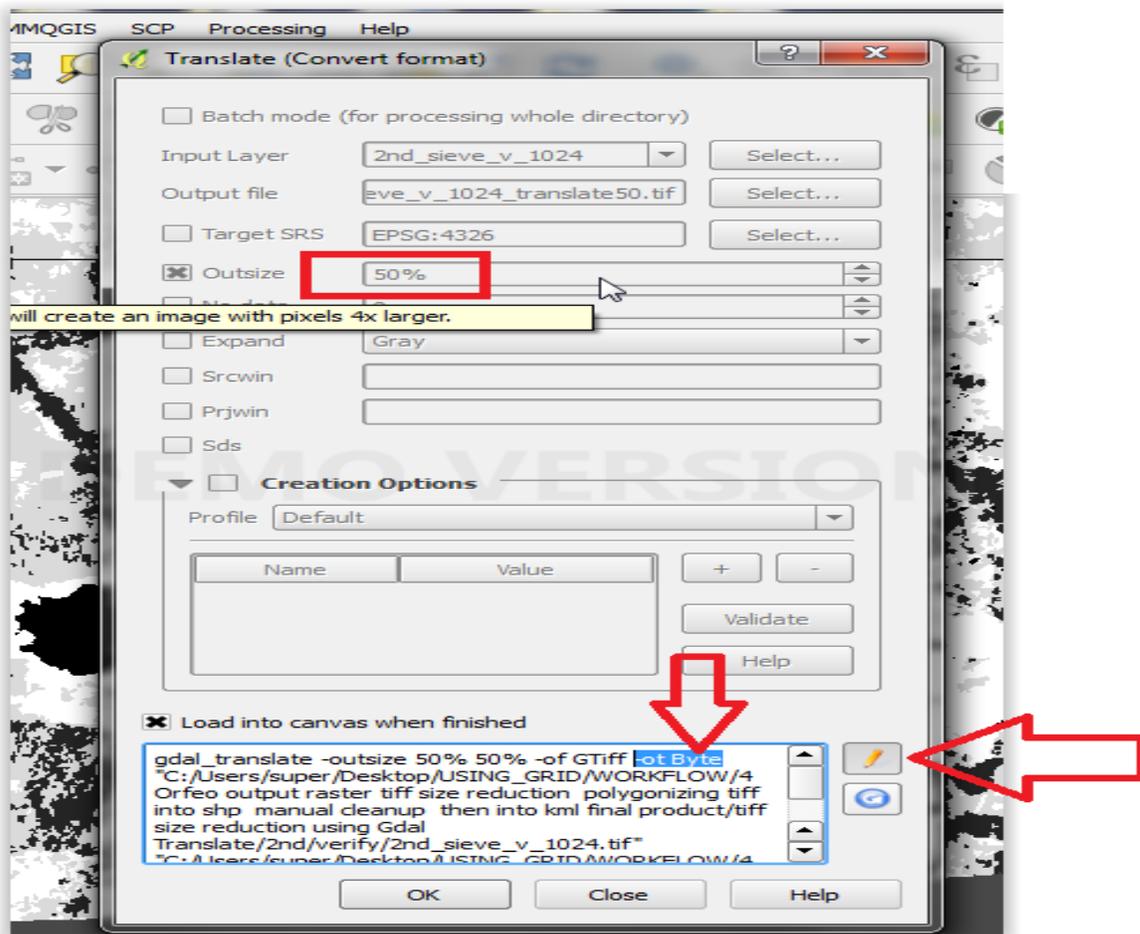
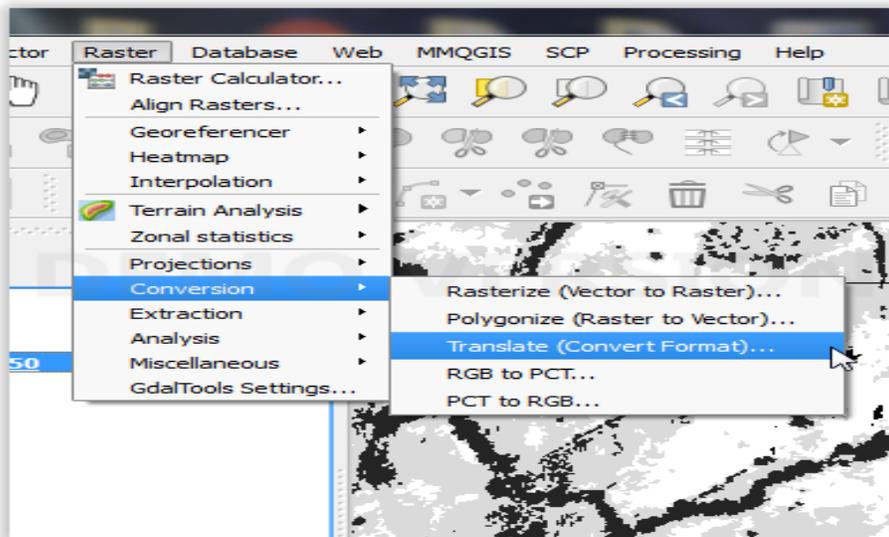


C) Reduce Orfeo output tiff size

1. Raster > Conversion > Translate (Convert Format)
2. Output file = "name... translate50.tiff"
3. Check Outsize = 50%
4. Click the Pencil icon > add **"-ot Byte"** after **"-of Gtiff"**
5. Click OK

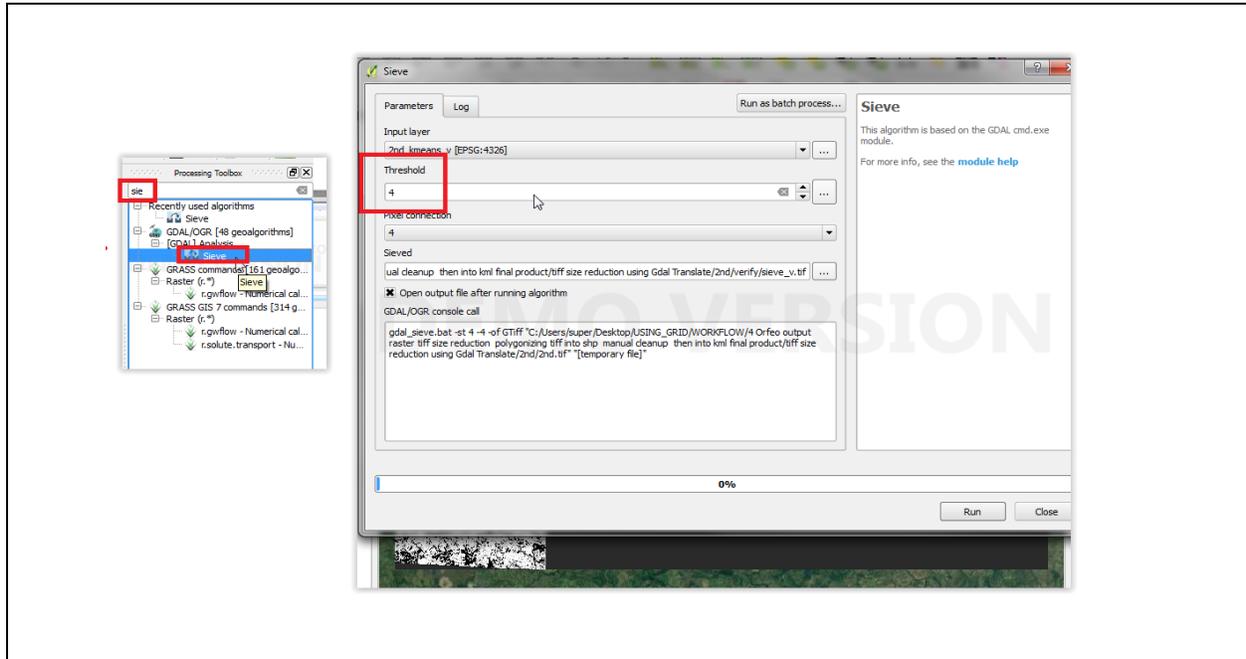


- <http://gis.stackexchange.com/questions/215387/extracting-raster-classes-and-creating-new-raster-that-is-smaller-in-size-usin>



D) Running the sieve tool

1. Type “sie” into Processing Toolbox search
2. Double click “Sieve”
3. Input layer = “name... translate50.tiff” Threshold = 4
4. Output Sieved = “name...sieve.tiff”



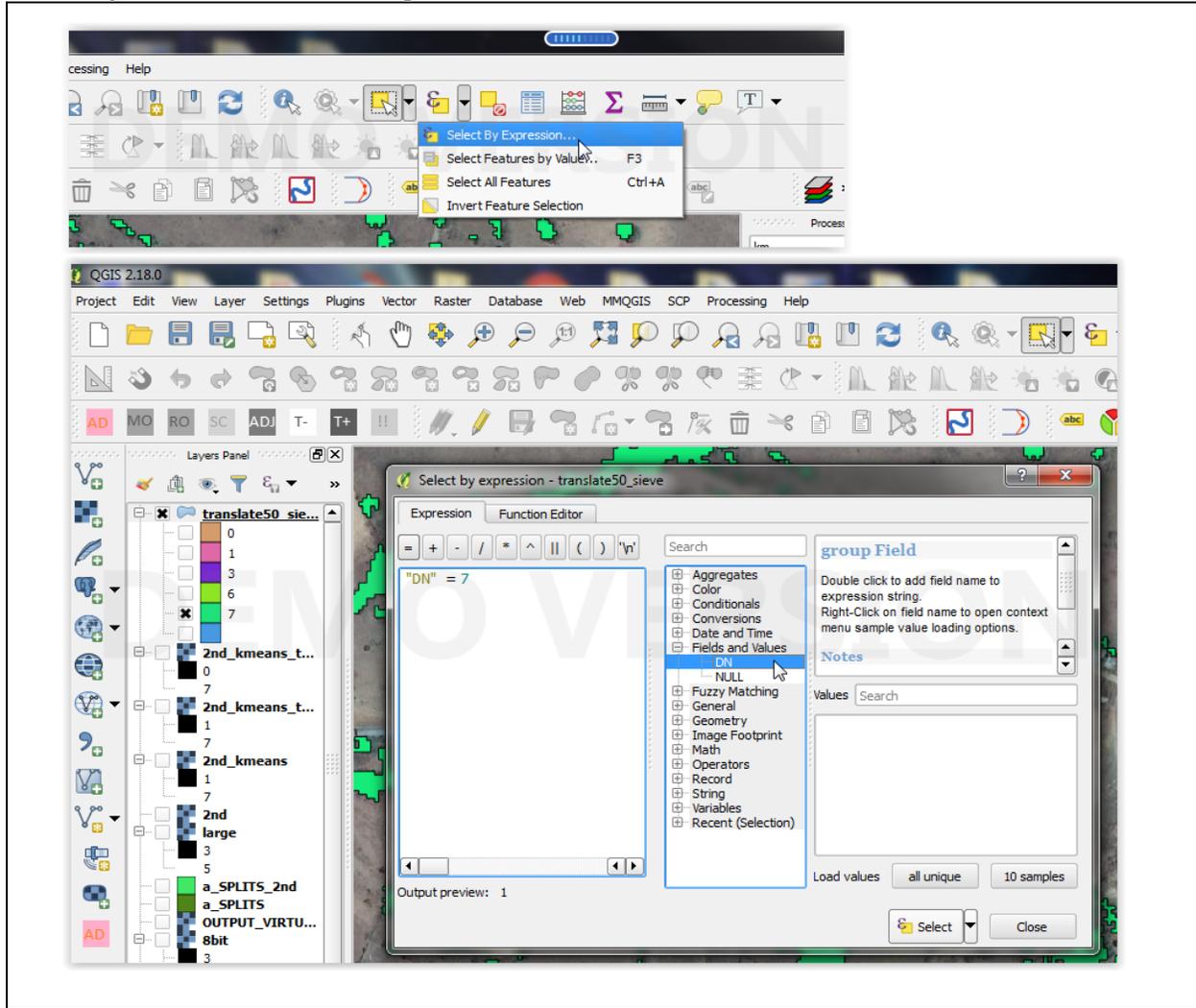
E) Polygonize and cleanup using select by expression

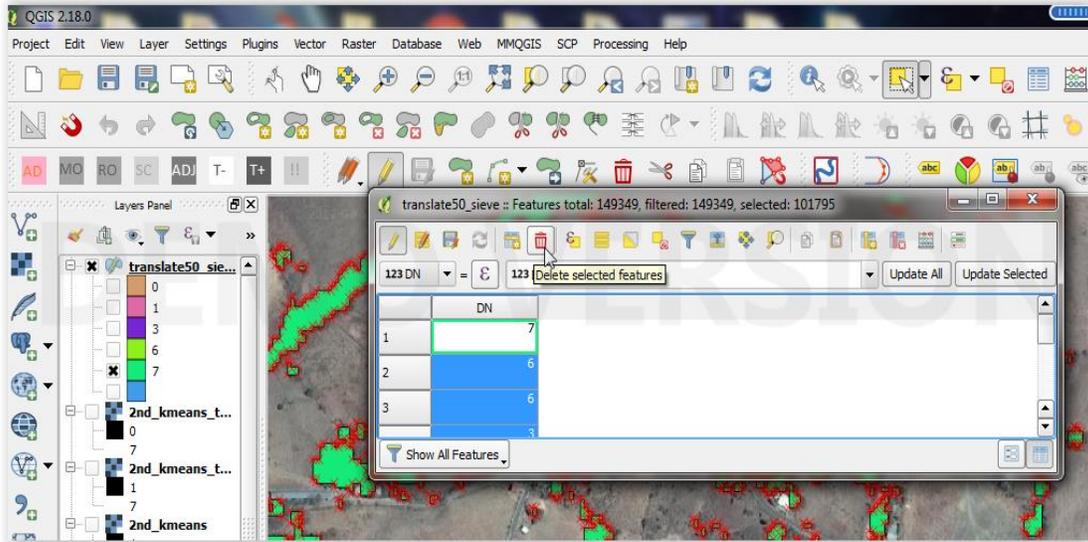
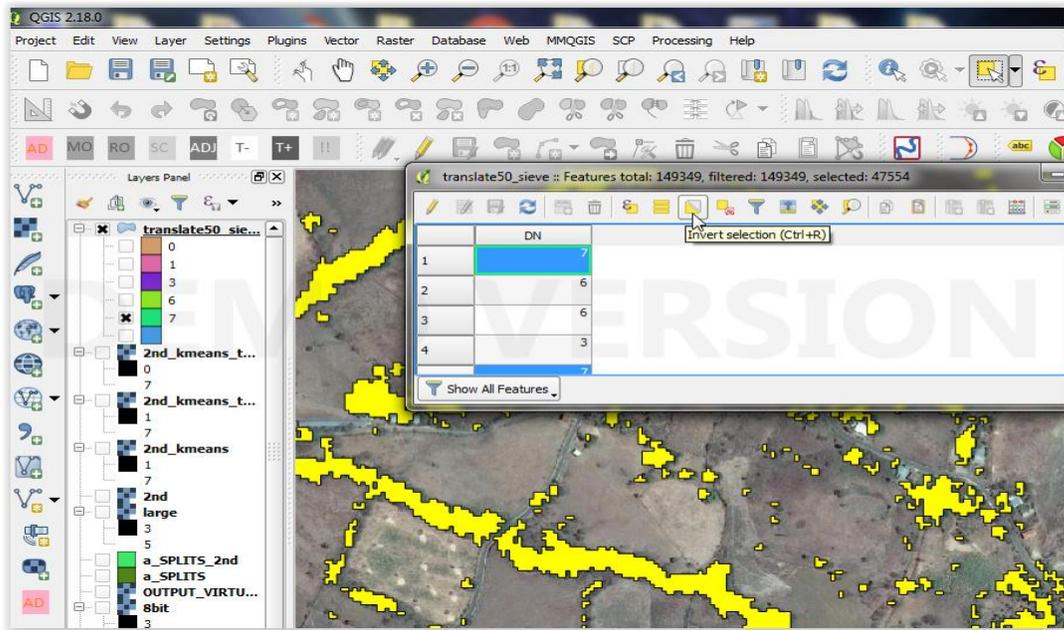
1. Open a fresh QGIS session.
2. Add the last tiff created “name...sieve.tiff” (layer> add layer> add raster layer)
3. Raster > Conversion > Polygonize (Raster to vector)
4. Field name = DN
5. Output file for polygons (shapefile) = “name...polygonize” and click OK.

F) Classify the new polygon shp by DN

1. Right click the new polygon shp > Toggle Editing
2. Right click > Open Attribute Table
3. Click “Select features using an expression” button
4. Field and Values > DN = 7 (or whatever tree class is in your shp)
 - To check for the correspondent value of the tree class (or whatever class you are interested), Use the select feature by area button to choose a feature that you know is a tree; Open Attribute Table, in the bottom part of the attribute table choose the show selected features, see the value that you are interested
5. Click Invert selection button
6. Click Delete selected features
7. Toggle Editing > Save

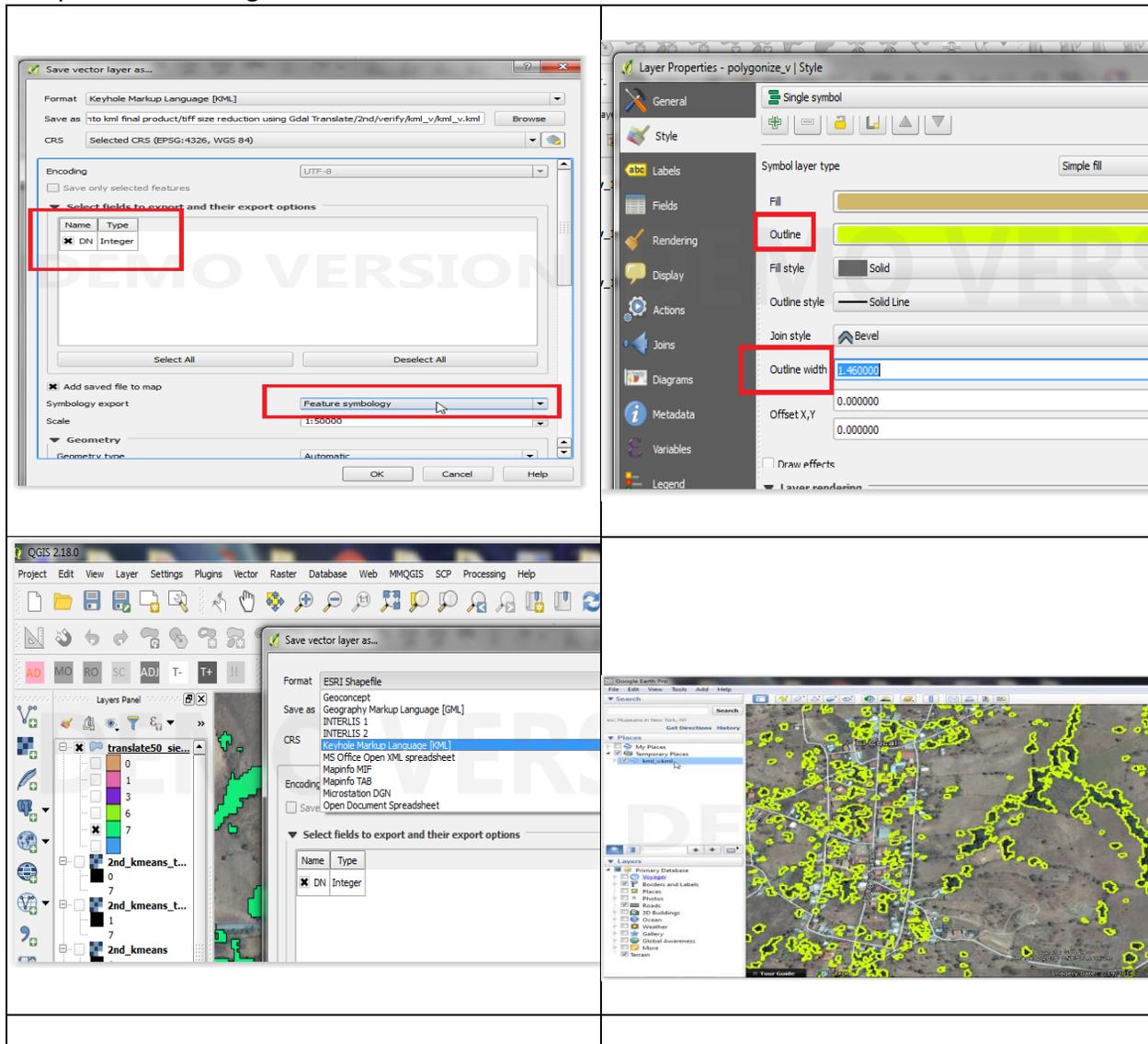
*manual clean up can also be done using the “Reshape Features” tool in an editing session as needed, just make sure to save updates often.





G) Save as kml and view in google earth

1. Open a fresh QGIS session.
2. Bring in the latest polygon “name....polygonize”
3. Right Click > Style > Outline = Lime Green
4. Outline width = 1.46
5. Right Click > Save vector layer as = Keyhole Markup Language [KML]
6. Check box DN Integer
7. Symbol export = Feature symbology
8. Open KML in Google Earth.



7. EXTRACT INFORMATION FOR THE CLASSIFICATION.

