The advantages of using drones over space-borne imagery in the mapping of mangrove forests: Data Analysis Protocol

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Abstract

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Protocol

Geotagging Images

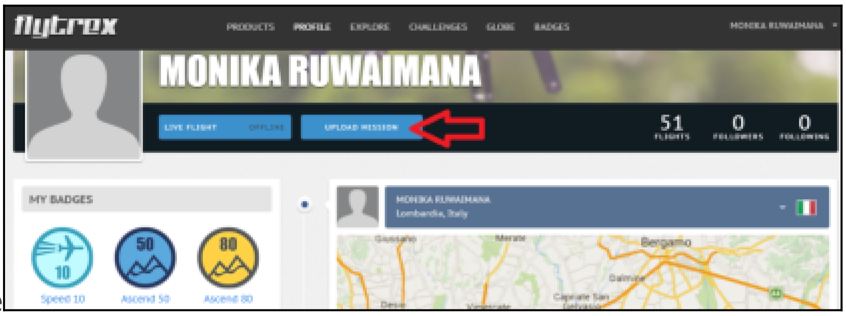
Step 1.

Take out the memory card from Flytrex device. Open it on a computer and copy the flight log data with extension .fvp

Geotagging Images

Step 2.

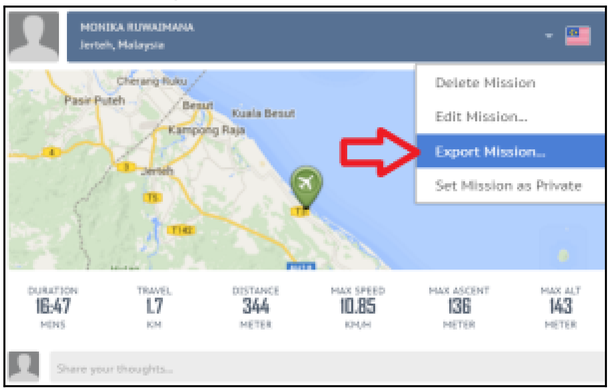
Create an account and sign-in at flytrex.com. On the profile page, click “Upload Mission”, and upload the .fpv file



Geotagging Images

Step 3.

On the uploaded mission, click drop-down-arrow next to the country flag, and choose “Export Mission”. Then select option “Download CSV”



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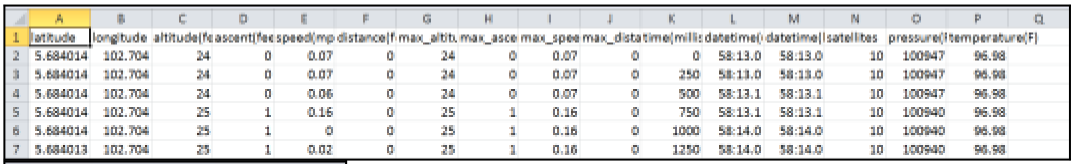
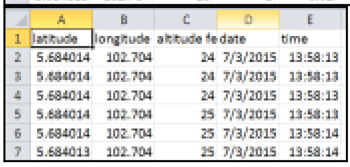
Geotagging Images

Step 4.

Open the .csv file using Microsoft Excel. This file contains complete flight information. Delete the columns, except latitude, longitude, altitude feet, and datetime. Divide datetime column into date and time. The original time is in GMT time, therefore, change the hour so it fits with the local time (in this case, add 8 hour as Malaysia is GMT+8). Save the file and close the Excel.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	latitude	longitude	altitude(fe	ascent(fee	speed(mp	distance(f	max_altit	max_asce	max_spee	max_dista	time(millis	datetime(	datetime(	satellites	pressure(I	temperature(F)	
2	5.684014	102.704	24	0	0.07	0	24	0	0.07	0	0	58:13.0	58:13.0	10	100947	96.98	
3	5.684014	102.704	24	0	0.07	0	24	0	0.07	0	250	58:13.0	58:13.0	10	100947	96.98	
4	5.684014	102.704	24	0	0.06	0	24	0	0.07	0	500	58:13.1	58:13.1	10	100947	96.98	
5	5.684014	102.704	25	1	0.16	0	25	1	0.16	0	750	58:13.1	58:13.1	10	100940	96.98	
6	5.684014	102.704	25	1	0	0	25	1	0.16	0	1000	58:14.0	58:14.0	10	100940	96.98	
7	5.684013	102.704	25	1	0.02	0	25	1	0.16	0	1250	58:14.0	58:14.0	10	100940	96.98	

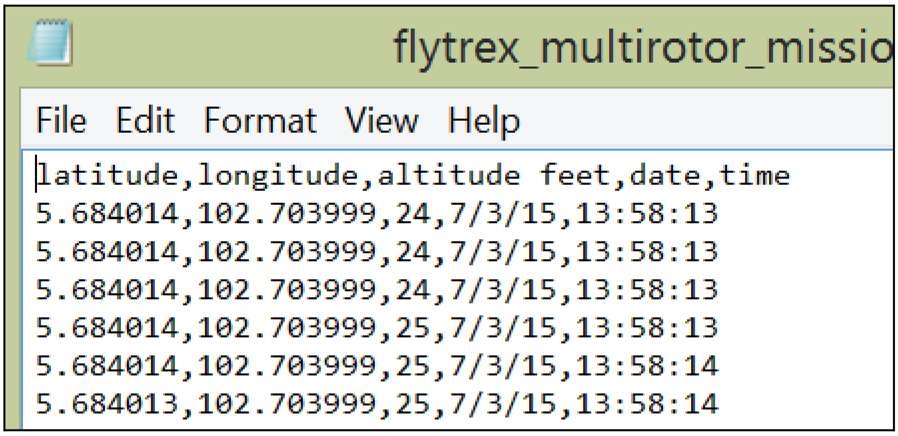


	A	B	C	D	E
1	latitude	longitude	altitude fe	date	time
2	5.684014	102.704	24	7/3/2015	13:58:13
3	5.684014	102.704	24	7/3/2015	13:58:13
4	5.684014	102.704	24	7/3/2015	13:58:13
5	5.684014	102.704	25	7/3/2015	13:58:13
6	5.684014	102.704	25	7/3/2015	13:58:14
7	5.684013	102.704	25	7/3/2015	13:58:14

Geotagging Images

Step 5.

Open the file with Notepad, select all text and copy it. Open gpsvisualizer.com, select option "Convert to GPX"




```
latitude,longitude,altitude feet,date,time
5.684014,102.703999,24,7/3/15,13:58:13
5.684014,102.703999,24,7/3/15,13:58:13
5.684014,102.703999,24,7/3/15,13:58:13
5.684014,102.703999,25,7/3/15,13:58:13
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5.684013,102.703999,25,7/3/15,13:58:14
```

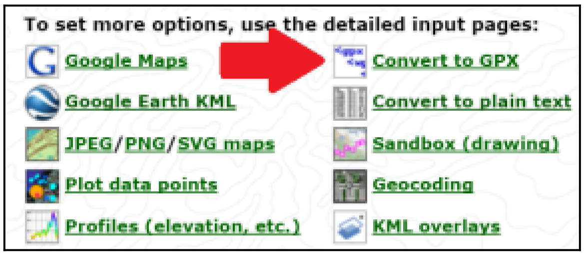

Geotagging Images

Step 6.

Paste the text data from .csv file on the window "paste your data here". Choose comma as "Plain text delimiter" and click "Convert"

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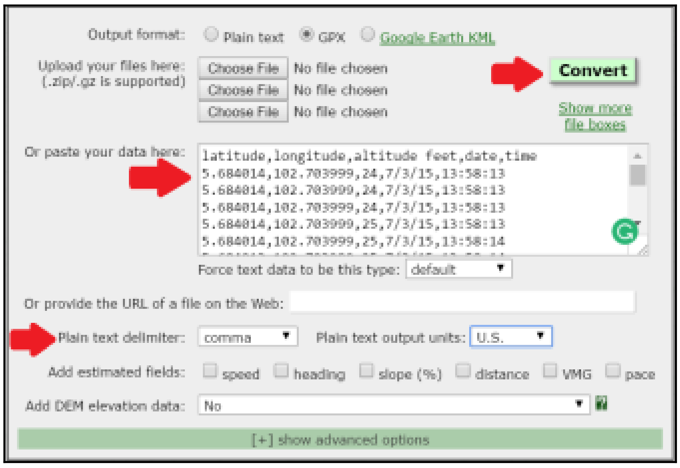


Geotagging Images

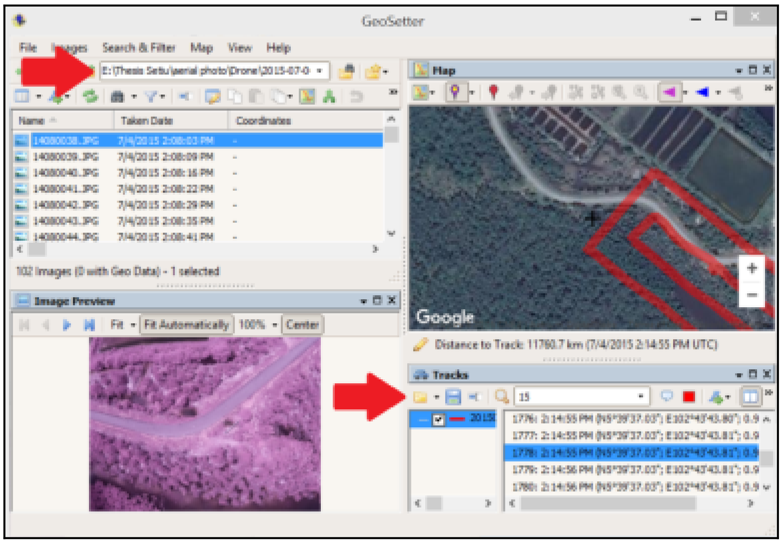
Step 7.

Click the provided link and download the .gpx data.

Geotagging Images

Step 8.

Download and install free software GeoSetter from http://www.geosetter.de/en/. Open the GeoSetter. On the upper left directory dropdown, select the folder containing the drone images. On the bottom right, click the icon open and open the .gpx file from the previous step. A Google map on the upper right window will show the drone track.



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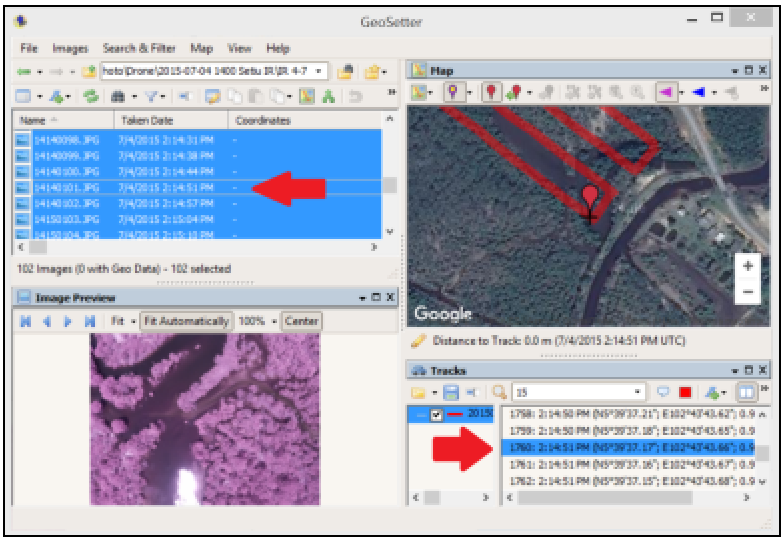
Geotagging Images

Step 9.

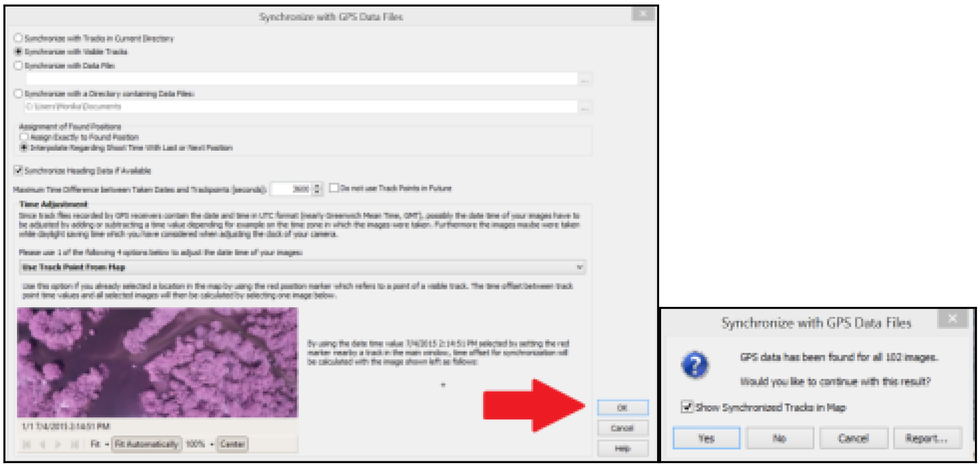
Select an image which is located more or less in the middle of image list, and select the record with same minutes and seconds from the window “Tracks”. Click shortcut ctrl-A to select all the images



Geotagging Images

Step 10.

Click menu “Images”, then choose “Synchronize with GPS data file” or just push the shortcut button ctrl-G to open Synchronize window. Click “OK” button on the bottom left. Then click “Yes” on the pop-up window.



Geotagging Images

Step 11.

The coordinates for each image will appear. Click the save icon. Images are tagged and ready for processing.

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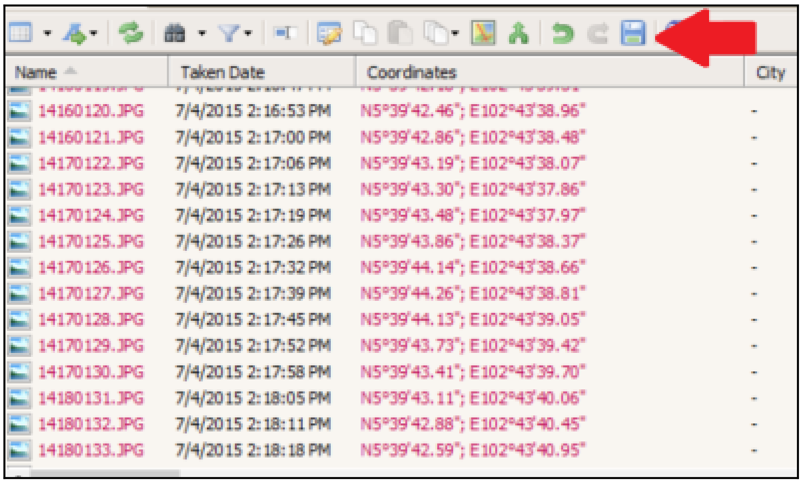


Generating Mosaic Image

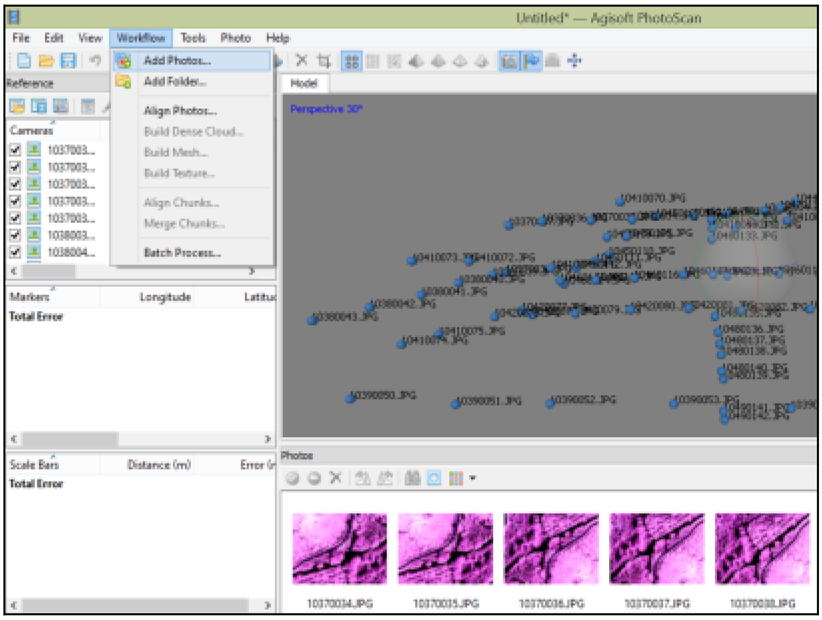
Step 12.

Install Agisoft Photoscan Professional with license.

Generating Mosaic Image

Step 13.

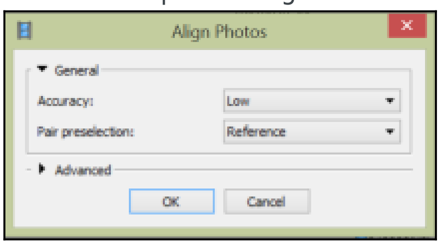
Click the menu “Workflow”, then “Add Photos”. Choose all the geotagged images from the directory.



Generating Mosaic Image

Step 14.

Click the menu “Workflow”, then “Align photos”. Choose the “Accuracy” setting “Low”, then click “OK”. Wait for the processing to finish.



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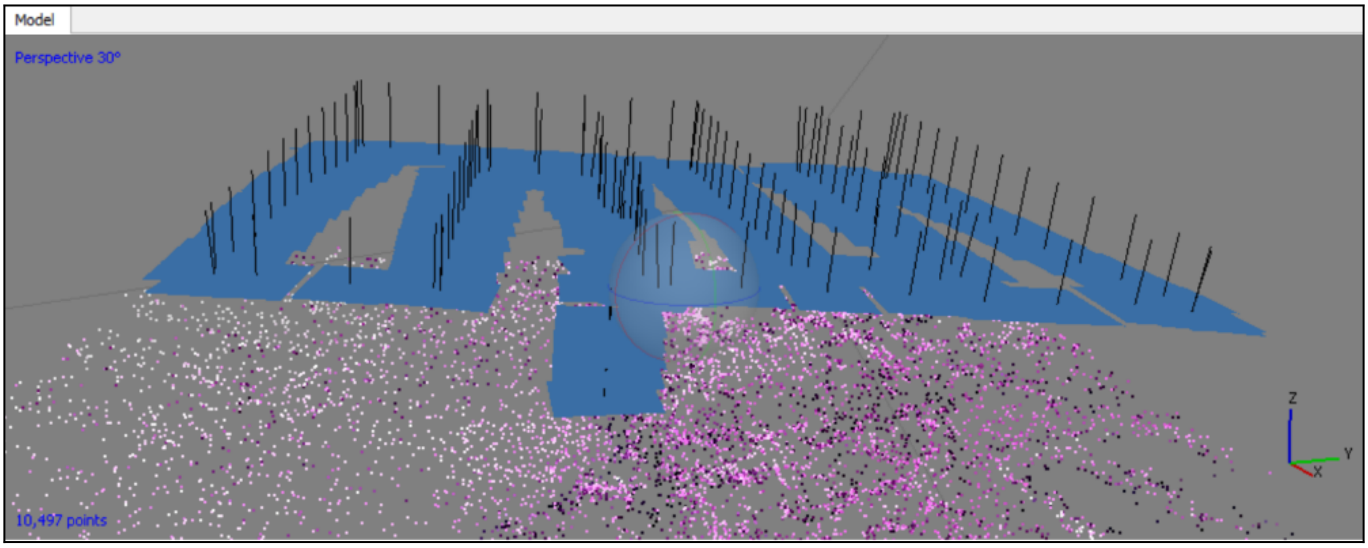
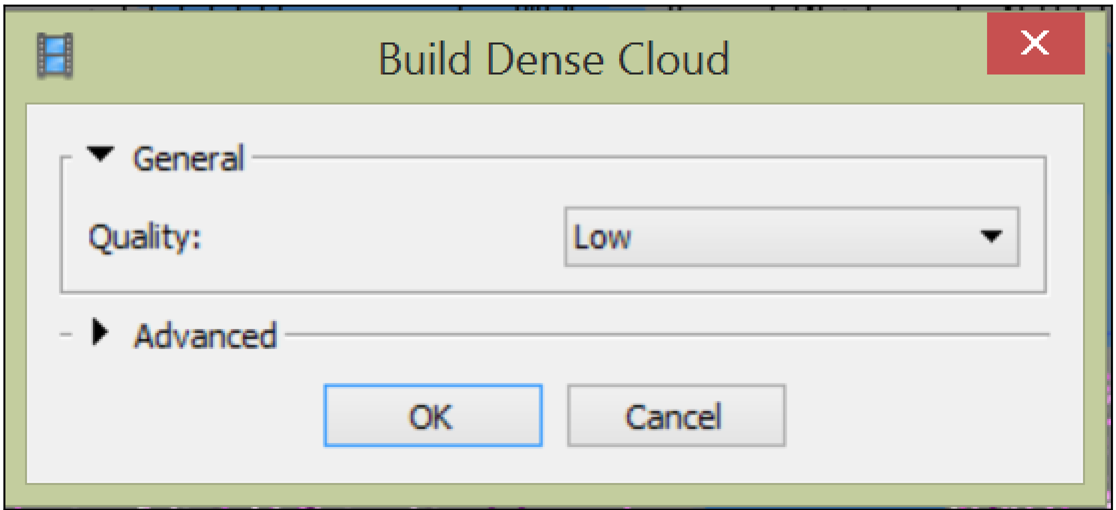
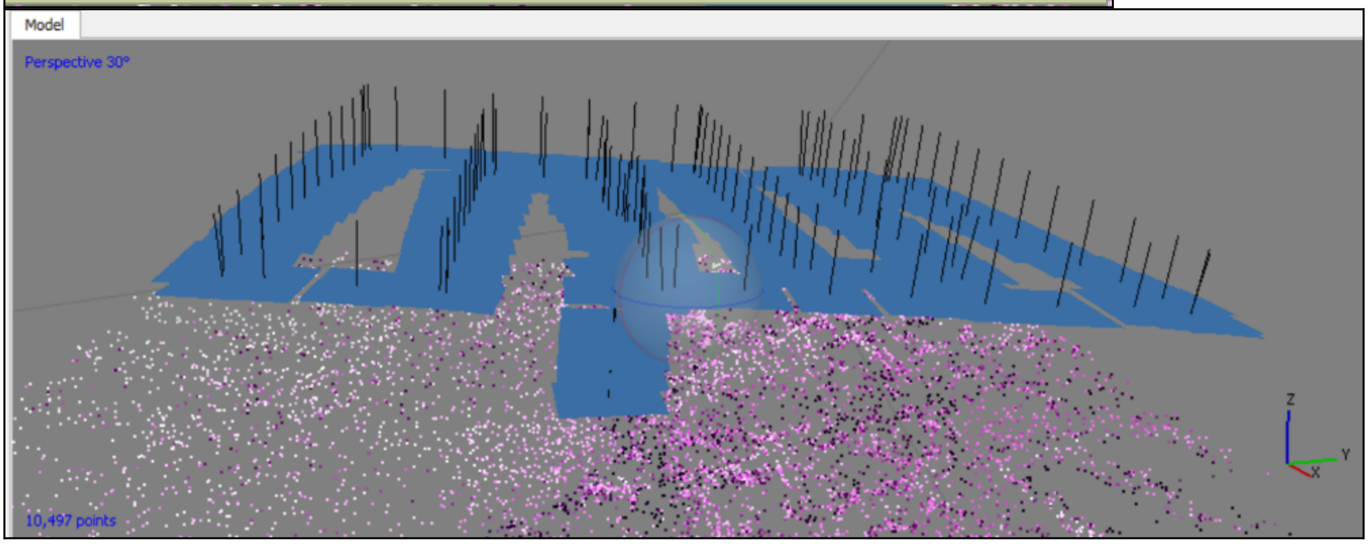


Generating Mosaic Image

Step 15.

Click the menu “Workflow”, then “Build Dense Cloud”. Choose the “Quality” setting “Low”, then click OK. Wait for the processing to finish.





Generating Mosaic Image

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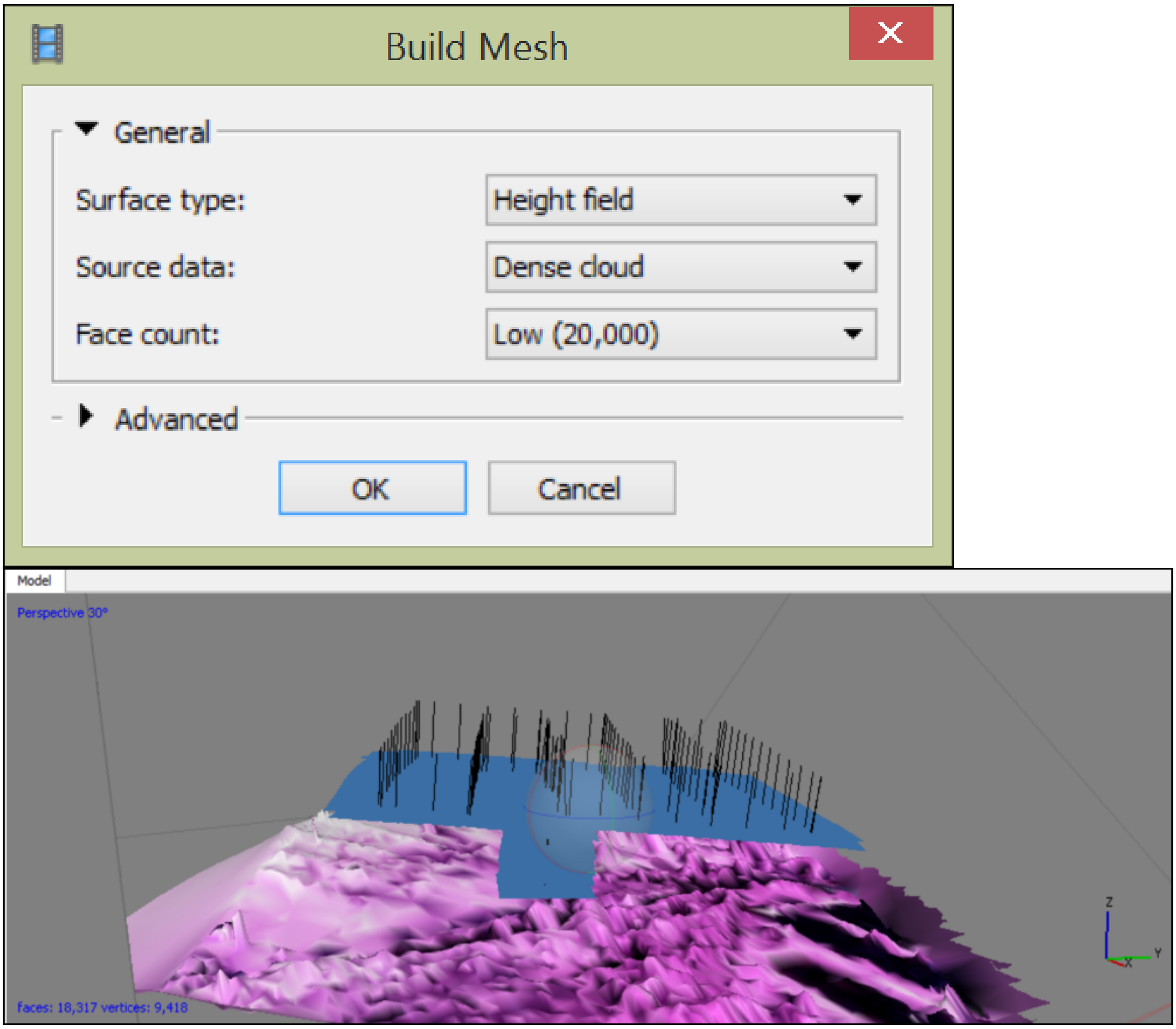
Step 16.

Click the menu “Workflow” then “Build Mesh”. Choose the “Face count” setting “Low”, then click “OK”. Wait for the processing to finish.



Generating Mosaic Image

Step 17.

Click the menu “Workflow” then “Build Texture”. Click “OK”. Wait for the processing to finish.

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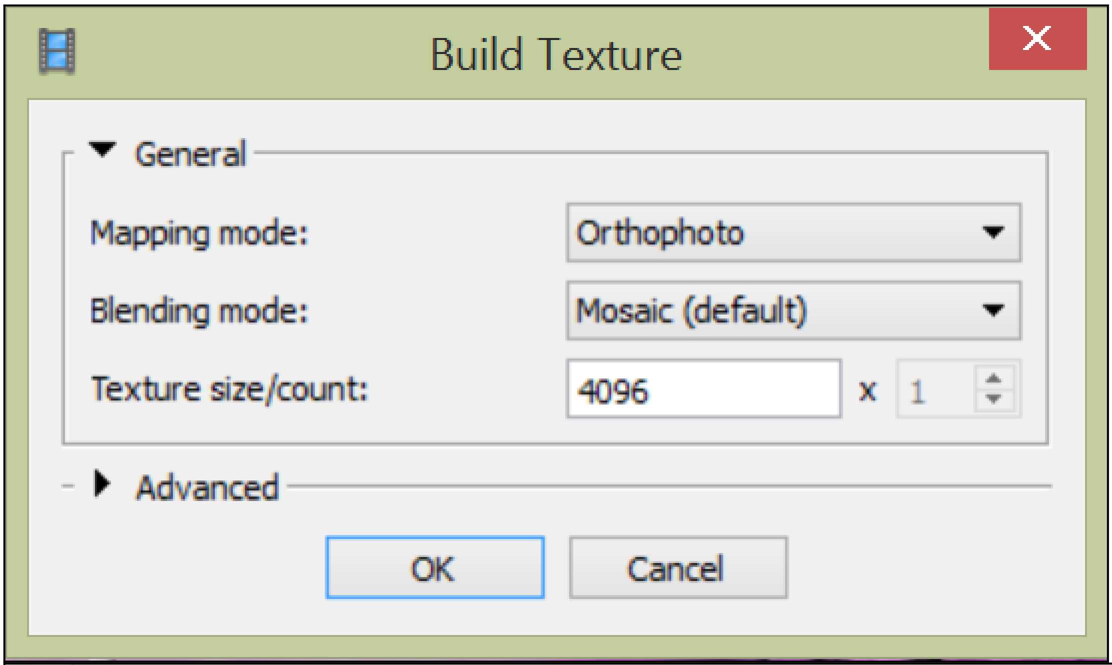

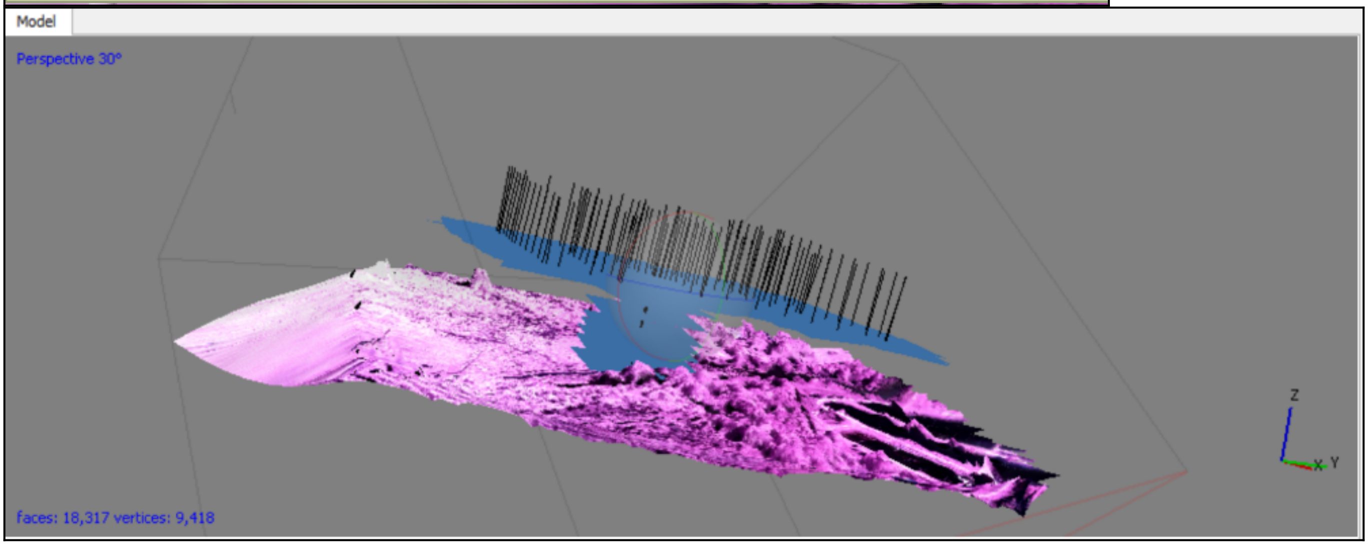

Generating Mosaic Image

Step 18.

Click the icon camera for clear view of the image.

Generating Mosaic Image

Step 19.

Open Google Earth, and zoom into the exact same area. Find a corresponding feature which can be useful for creating the control point.

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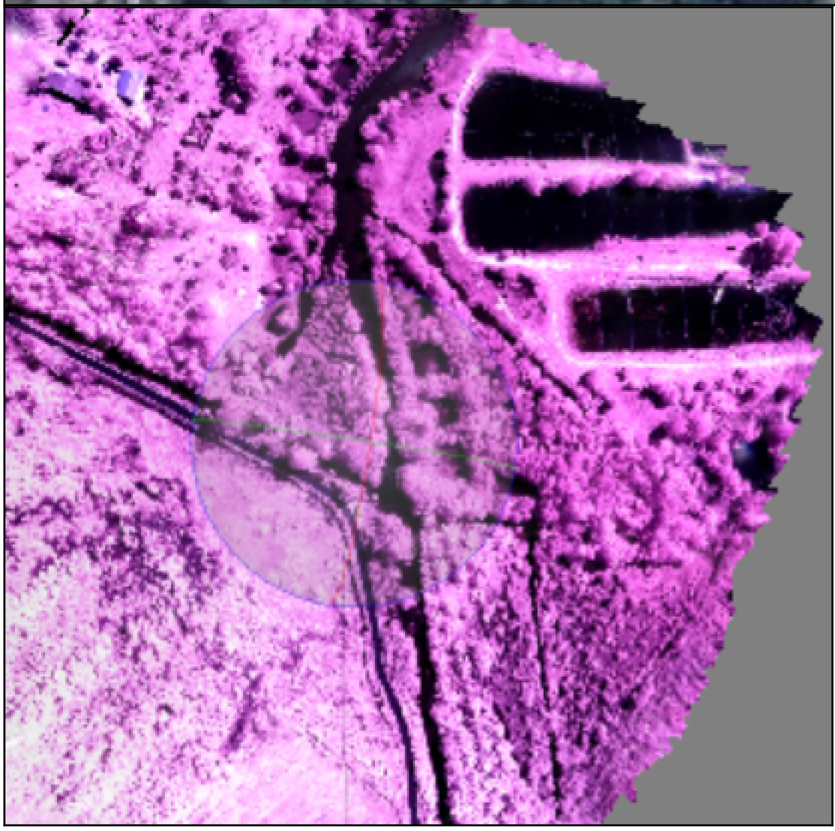

Generating Mosaic Image

Step 20.

On Agisoft, right click on the point and click “Create Marker”. A flag will appear on the image and a marker named “point 1” will appear on the Markers Panel on the left side of the screen.

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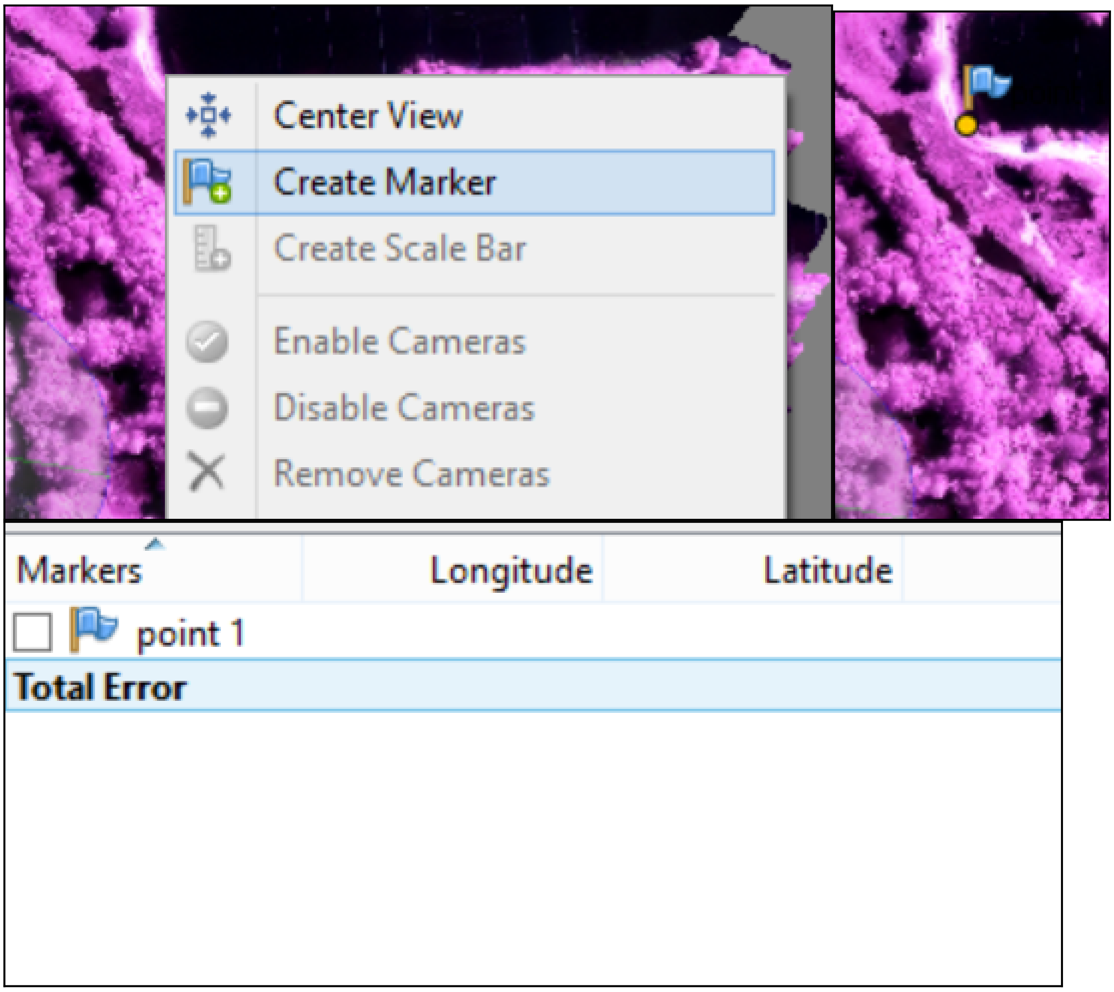
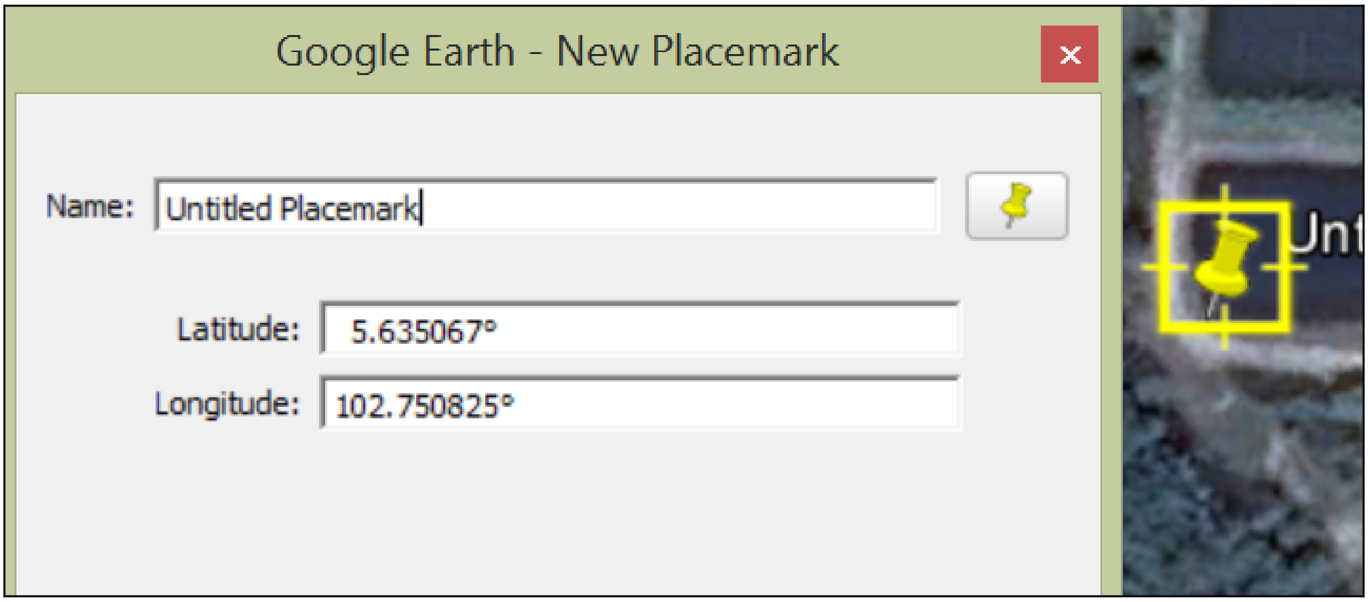


Generating Mosaic Image

Step 21.

On Google Earth, place a mark over the correspond point, and copy the latitude and longitude values to the Markers Panel in Agisoft. The coordinates must be in decimal degree format.



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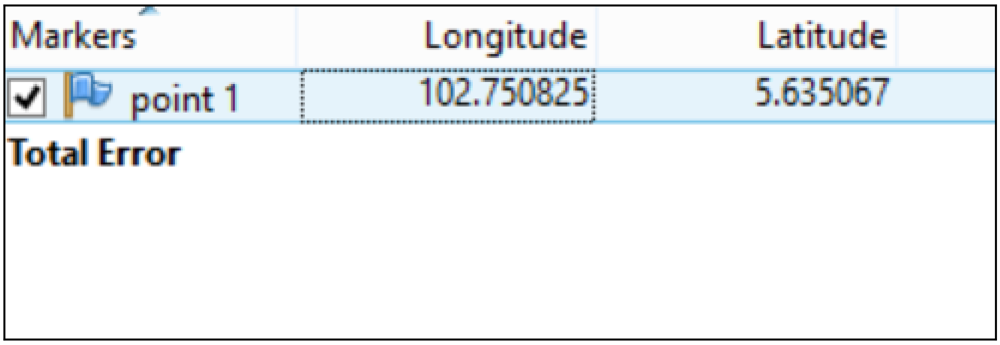


Generating Mosaic Image

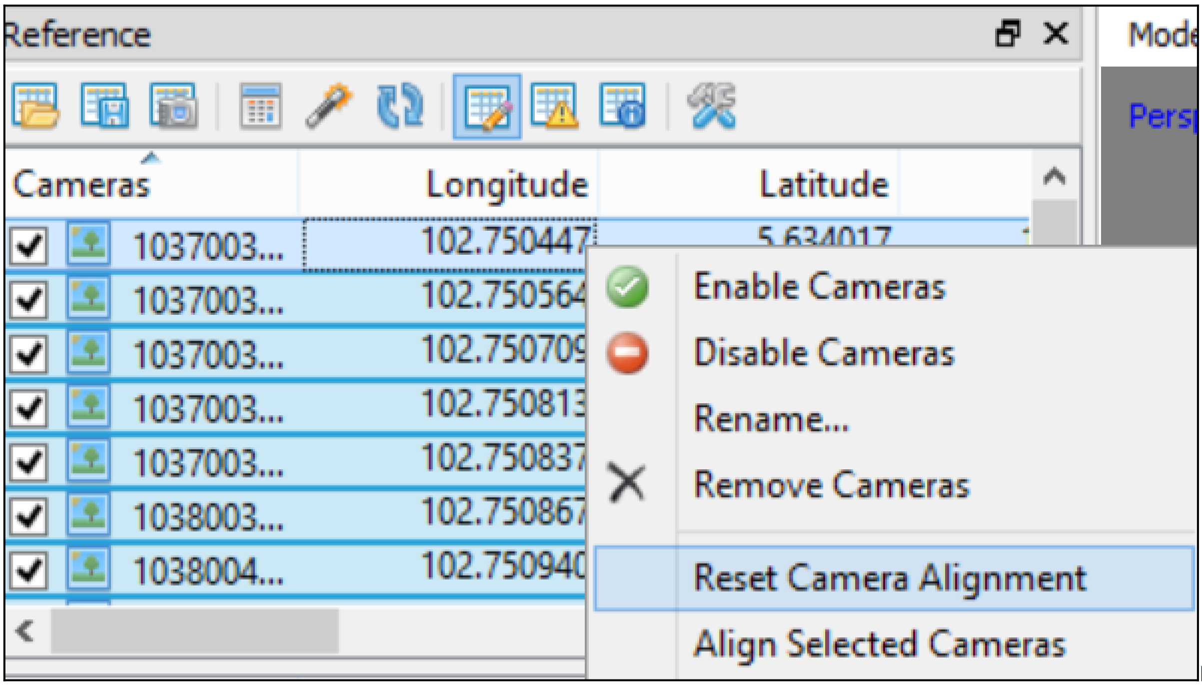
Step 22.

Repeat the process until at least 5 control points generated.

Generating Mosaic Image

Step 23.

On the panel “Reference”, located on the upper left, select all the cameras, then right click and choose “Reset Camera Alignment”, click “Yes” on the pop up window



Generating Mosaic Image

Step 24.

Repeat the “Workflow” process from “Align Photos” to “Build Texture”, but with setting medium or high. This depends on the capacity of the computer; using a computer with 2.6GHz processor and 8GB RAM, medium setting will take approximately 6 hours and high setting approximately 20 hours. This research was using medium setting.

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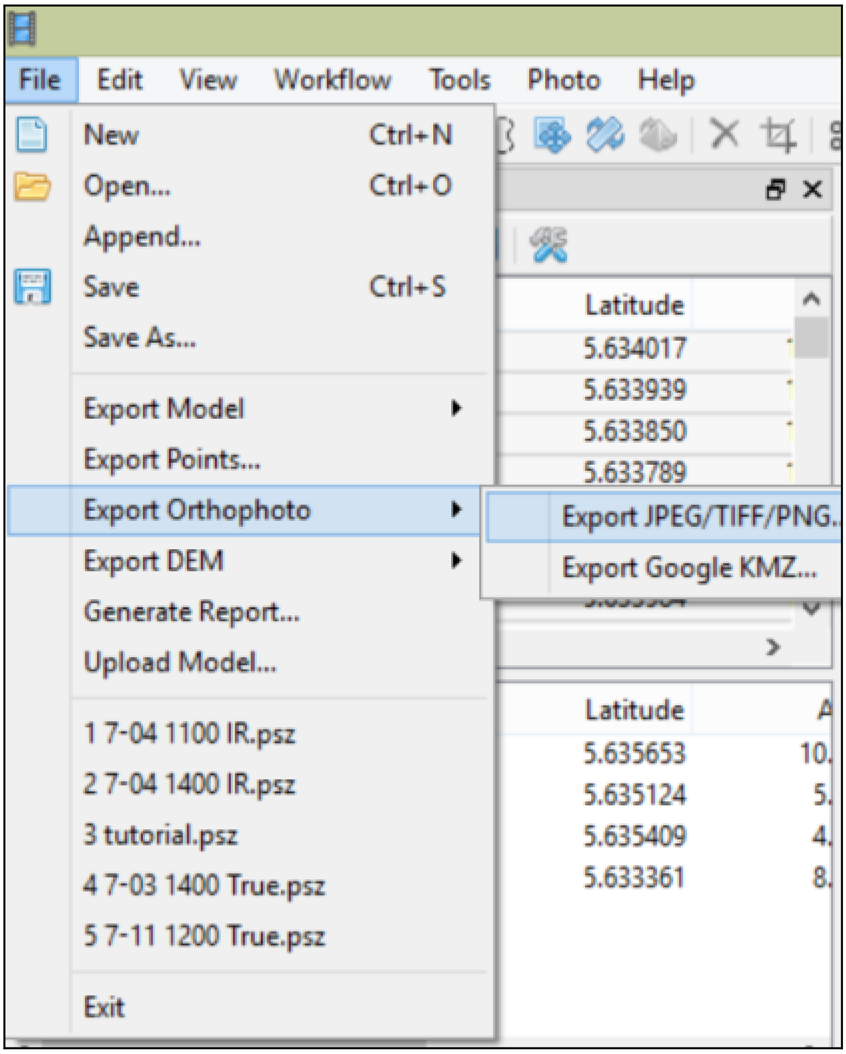
Generating Mosaic Image

Step 25.

Click menu “File” then “Export Orthophoto” then “Export JPEG/TIF..”. On the pop up window, choose coordinate system WGS 84/UTM zone 48N (Setiu’s UTM zone). On the “Pixel size”, fill 0.05 to give 5cm resolution. Tick the “Write World file” box, and click “Export”. Give name to the file and then click “Save”



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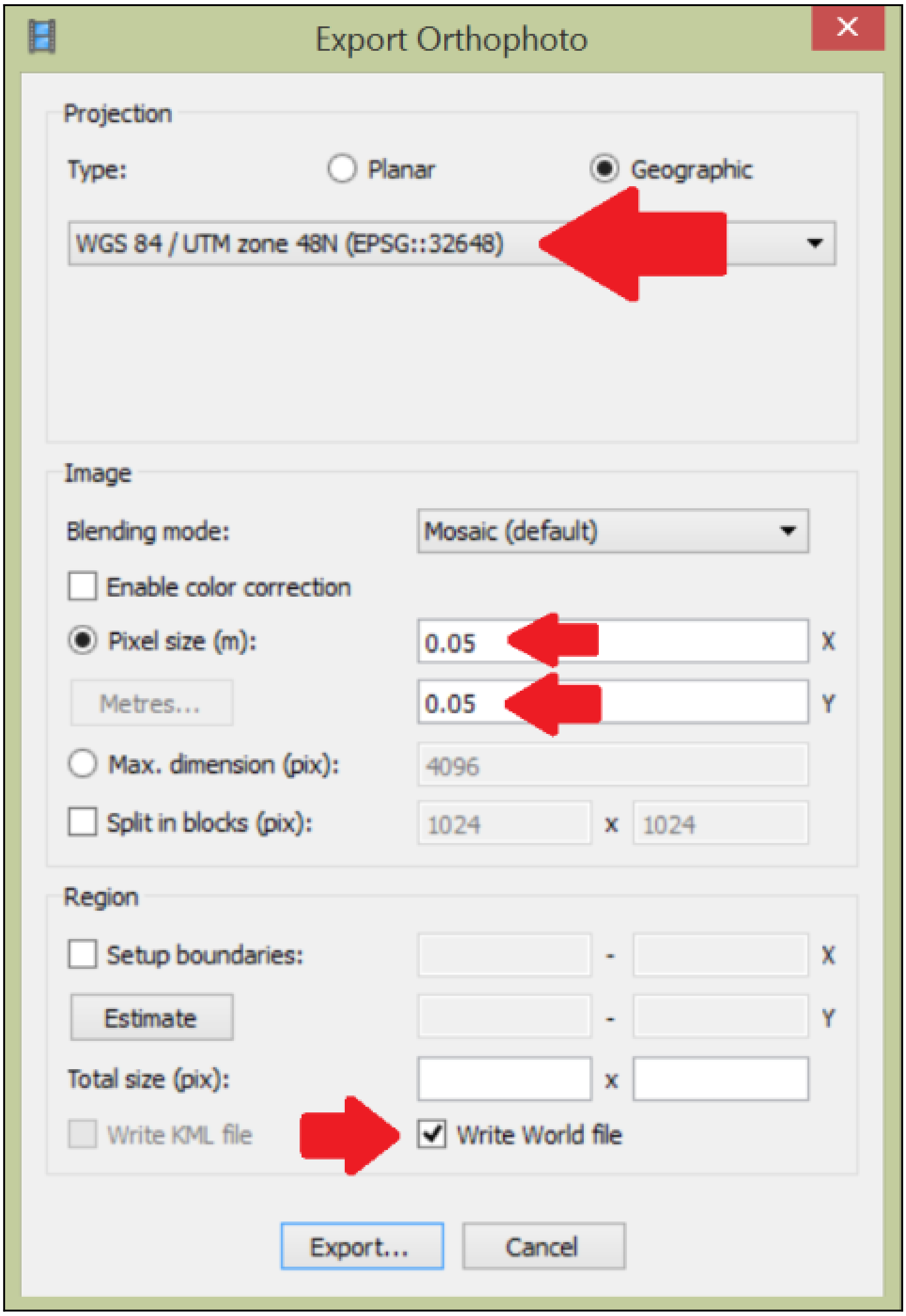

Generating Mosaic Image

Step 26.

Click menu “File” then “Export DEM” then “Export TIFF/BIL...”. On the pop up window, choose coordinate system WGS 84/UTM zone 48N (Setiu’s UTM zone). On the “Pixel size”, fill 0.05 to give 5cm resolution. Tick the”Write World file” box, and click “Export”. Give a name to the file and then click “Save”

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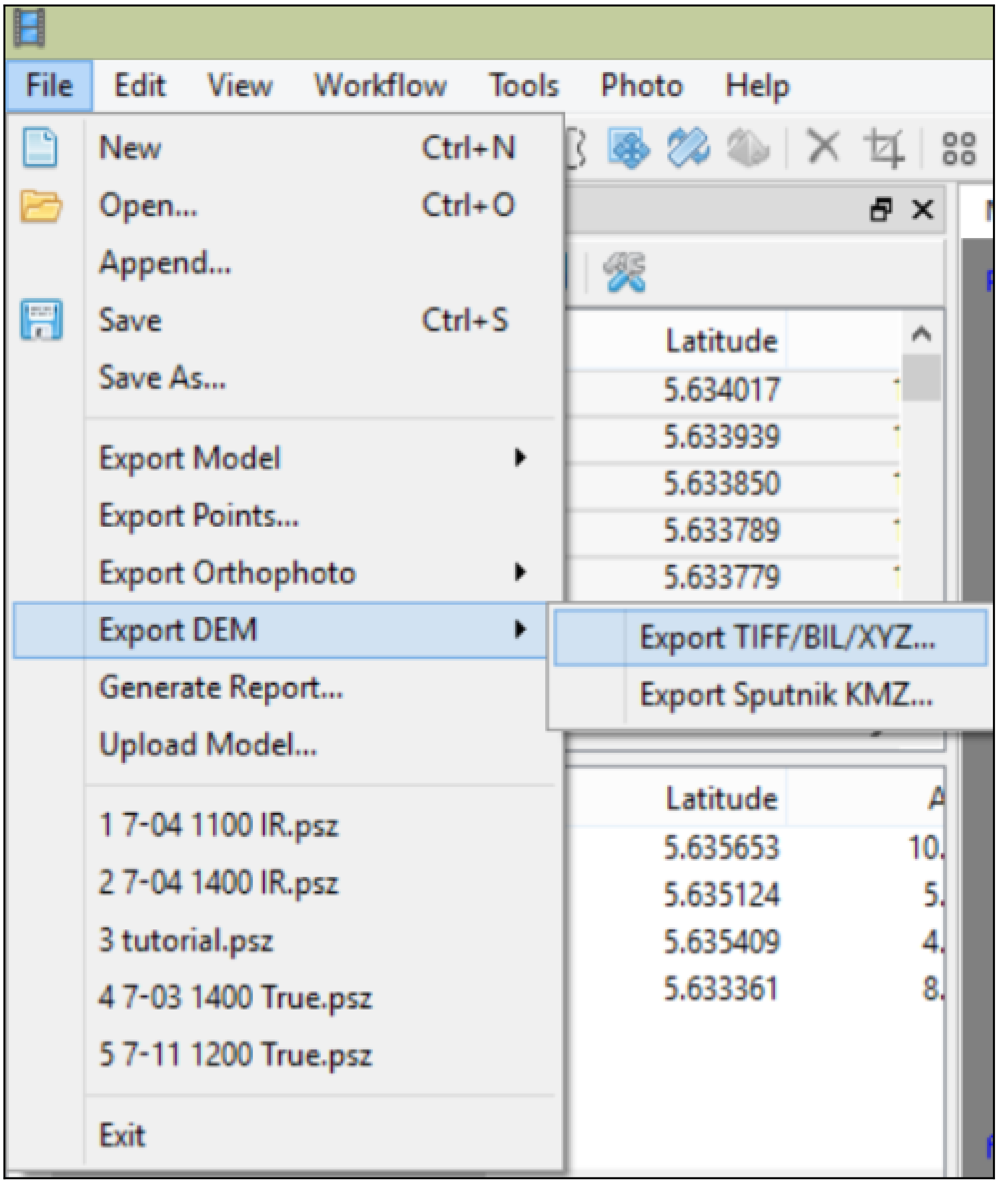

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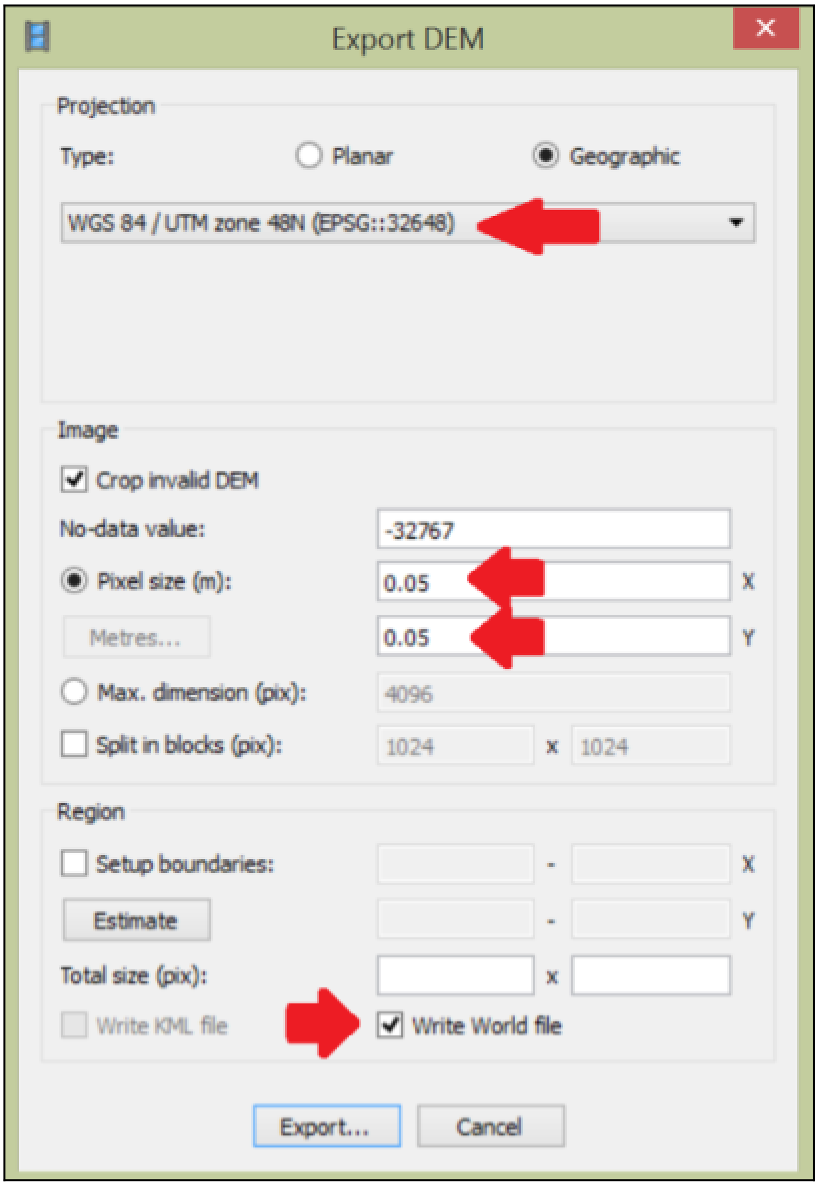


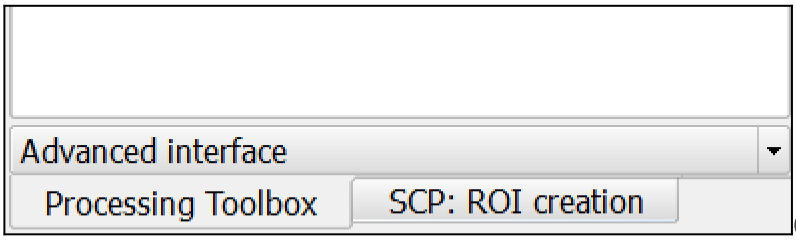
Image joining and georeferencing with satellite image

Step 27.

Download and install QGIS OSGeo4W advance package from qgis.org. This package is including ORFEO Toolbox and SAGA GIS.

Image joining and georeferencing with satellite image

Step 28.



Open QGIS. On the bottom left of "Processing Toolbox" panel, choose "Advanced Interface"

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Image joining and georeferencing with satellite image

Step 29.

Click menu “Layer” then “Add Layer” then “Add Raster Layer” or by clicking shortcut Ctrl-Shift-R. Open 3 complementary mosaic images : RGB, IR and DEM (for DEM, choose one of the RGB or IR, this research was using DEM from RGB, because RGB camera have a higher number of images on the same area, therefore, providing more detailed DEM)

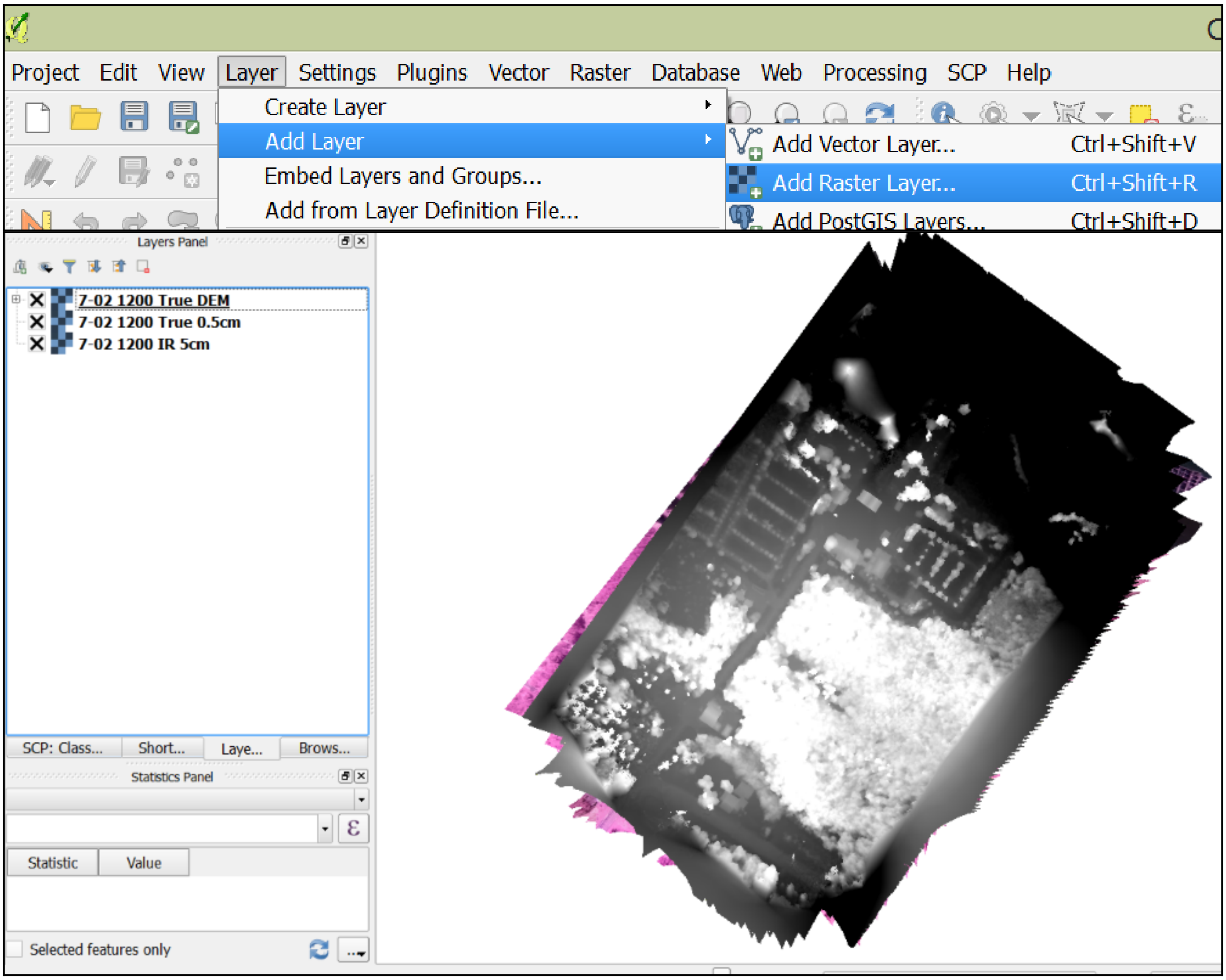

Image joining and georeferencing with satellite image

Step 30.

To make QGIS works faster, especially when zooming the images, right click on the image list, and choose “Properties”. On the pop up window, choose tab “Pyramids”. Select all list on the “Resolutions” tab, then click “Apply”. Repeat the process for all the images.

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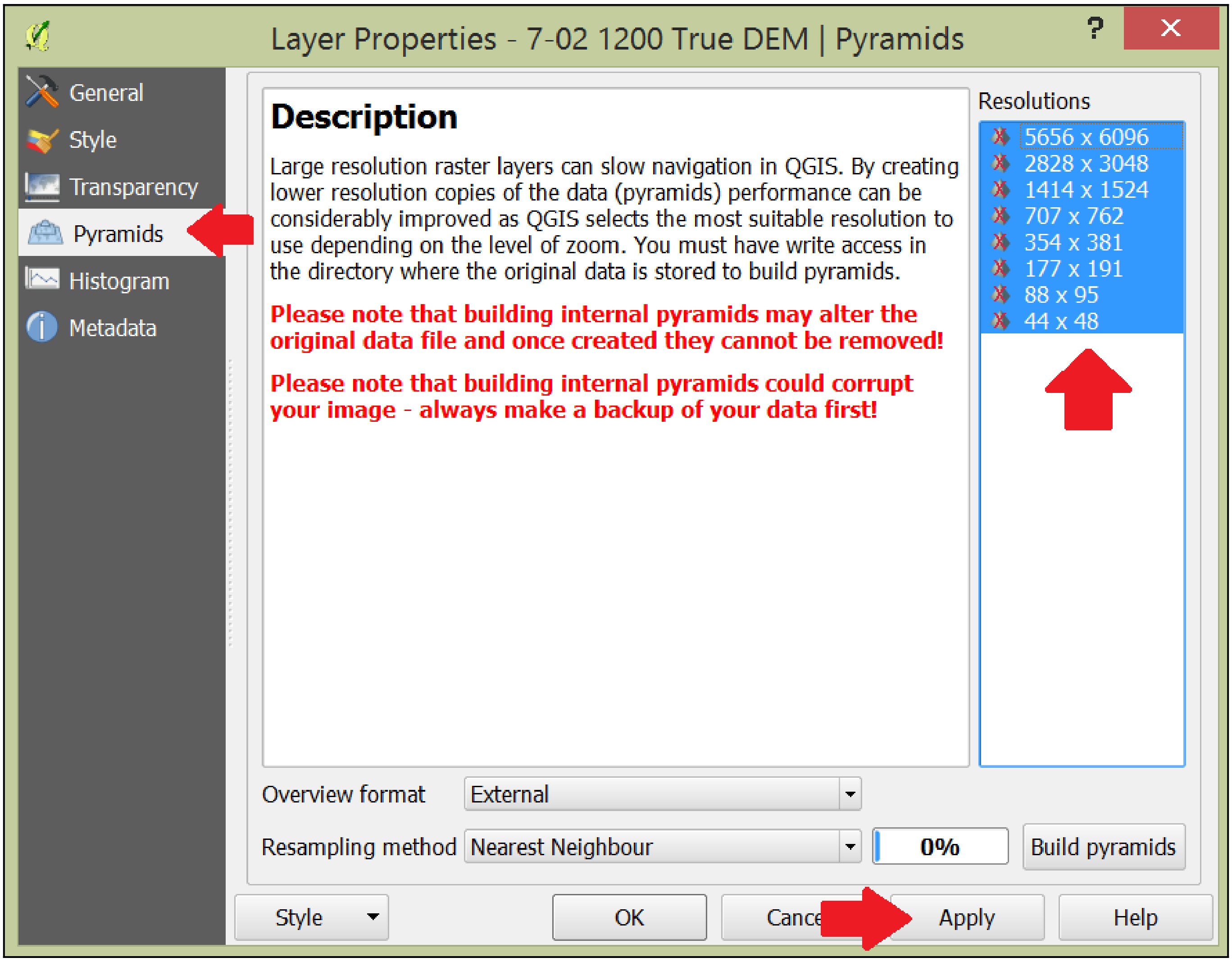
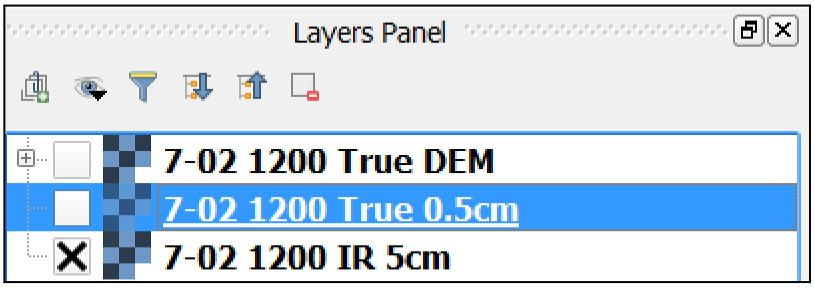


Image joining and georeferencing with satellite image

Step 31.

Check if the IR and RGB images are perfectly overlapped or not. Click and un-click the tick boxes next to image list on “Layers Panel” to make them appear or disappear. Additionally, open image “Properties” window, click on tab “Transparency” and adjust the “Global transparency”.



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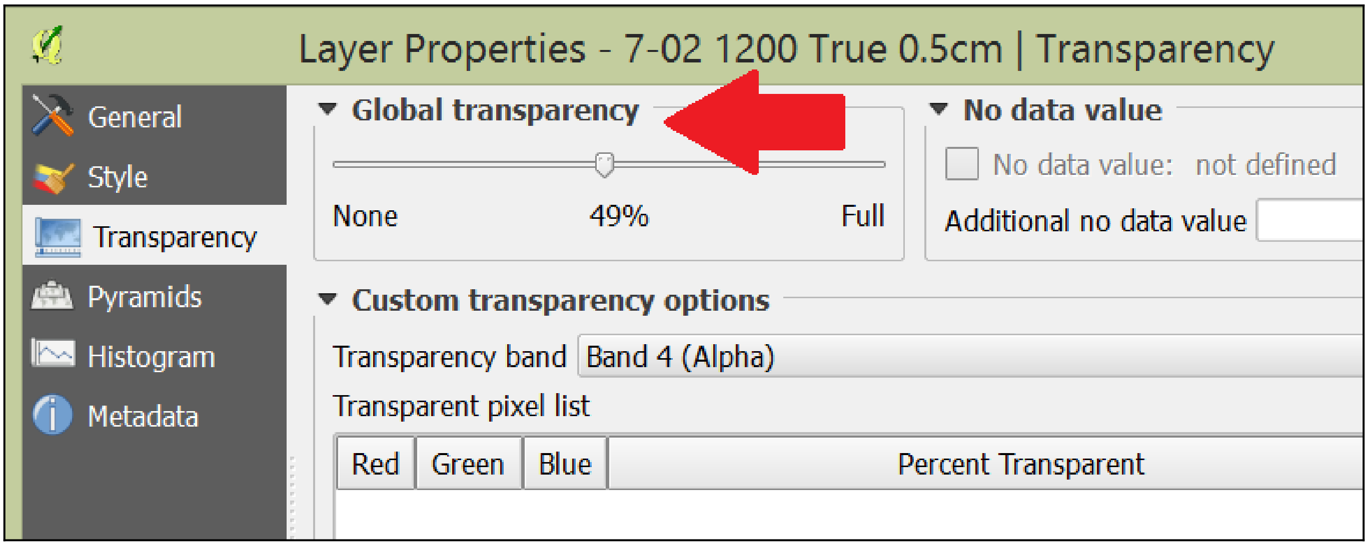

Image joining and georeferencing with satellite image

Step 32.

(Optional) Reference the IR image with RGB image if they are not perfectly overlapped. On the menu "Raster" choose "Georeferencer". On the opened Georeferencer window, click menu "File" and then "Open Raster". Choose the IR image file.

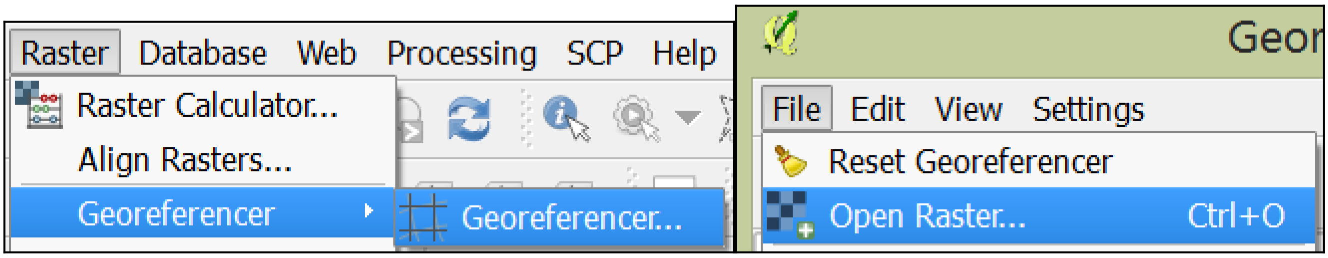

Image joining and georeferencing with satellite image

Step 33.

(Optional) On the Georeferencer window, click on the landmark which clearly visible on the image as the reference point (corner of a building or small individual tree *etc*.). On the pop up window, click "From map canvas". Click corresponding point from the RGB image. The coordinates of reference will fill automatically. Repeat the process to obtain at least 3 points (more is better; this research was using 7-8 points)

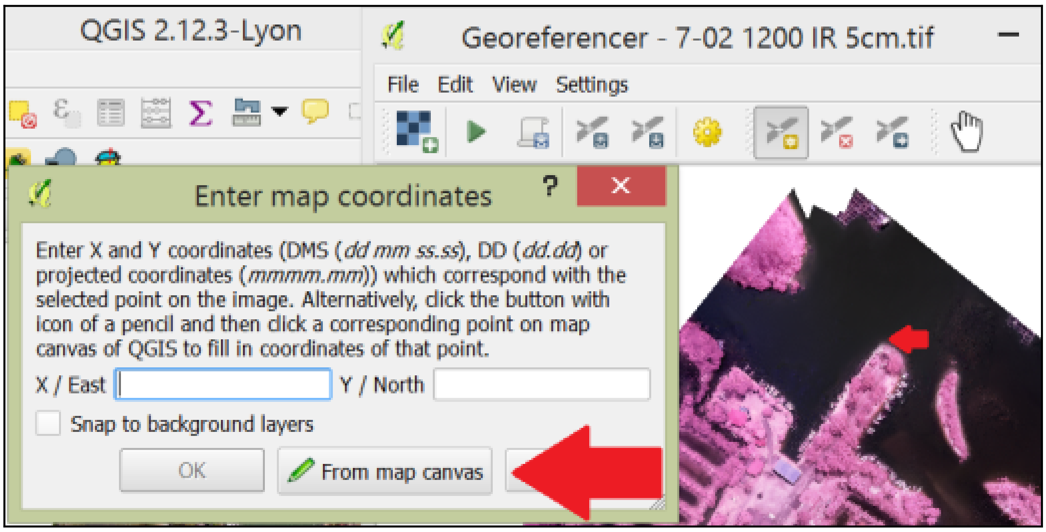

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Image joining and georeferencing with satellite image

Step 34.

(Optional) On the Georeferencer window, click menu “Setting” and “Transformation Setting”. On the Transformation type choose one type (this is trial and error process, so far the Polynomial Transformation gives better result). On the output raster, give the filename. Click OK and wait for the process. Close the Georeferencer window.

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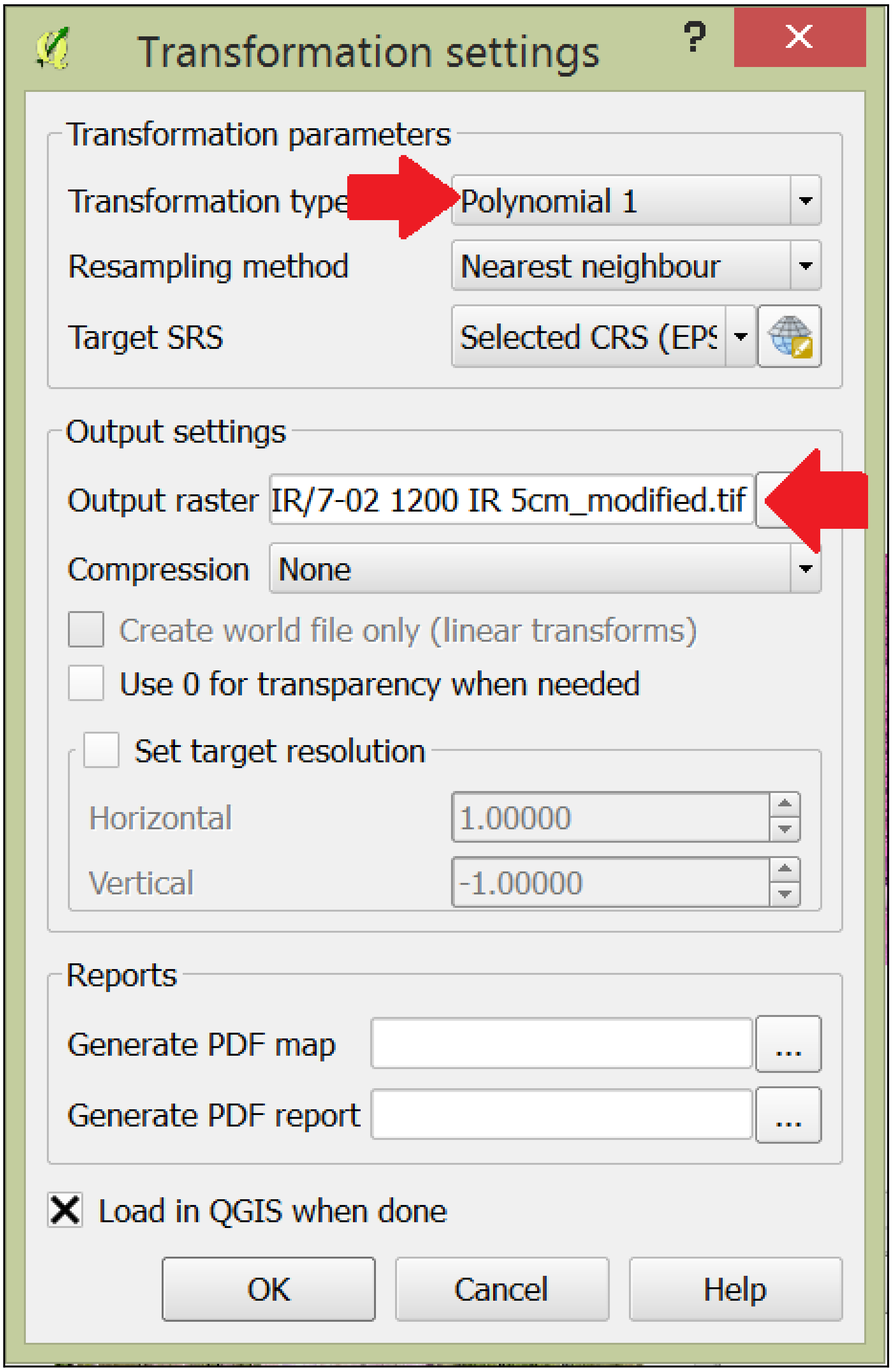

Image joining and georeferencing with satellite image

Step 35.

If the images are perfectly overlapped, join all the images. On the Processing Toolbox, type "Merge" and double-click on the GDAL Merge algorithm. On the opened Merge window, click on the Input layers and select all the images (IR, RGB and DEM). Tick the "Layer Stack". On the Merged tab, put the output file name, then, click Run. Wait until the process is finished (approximately 1-2 hours)

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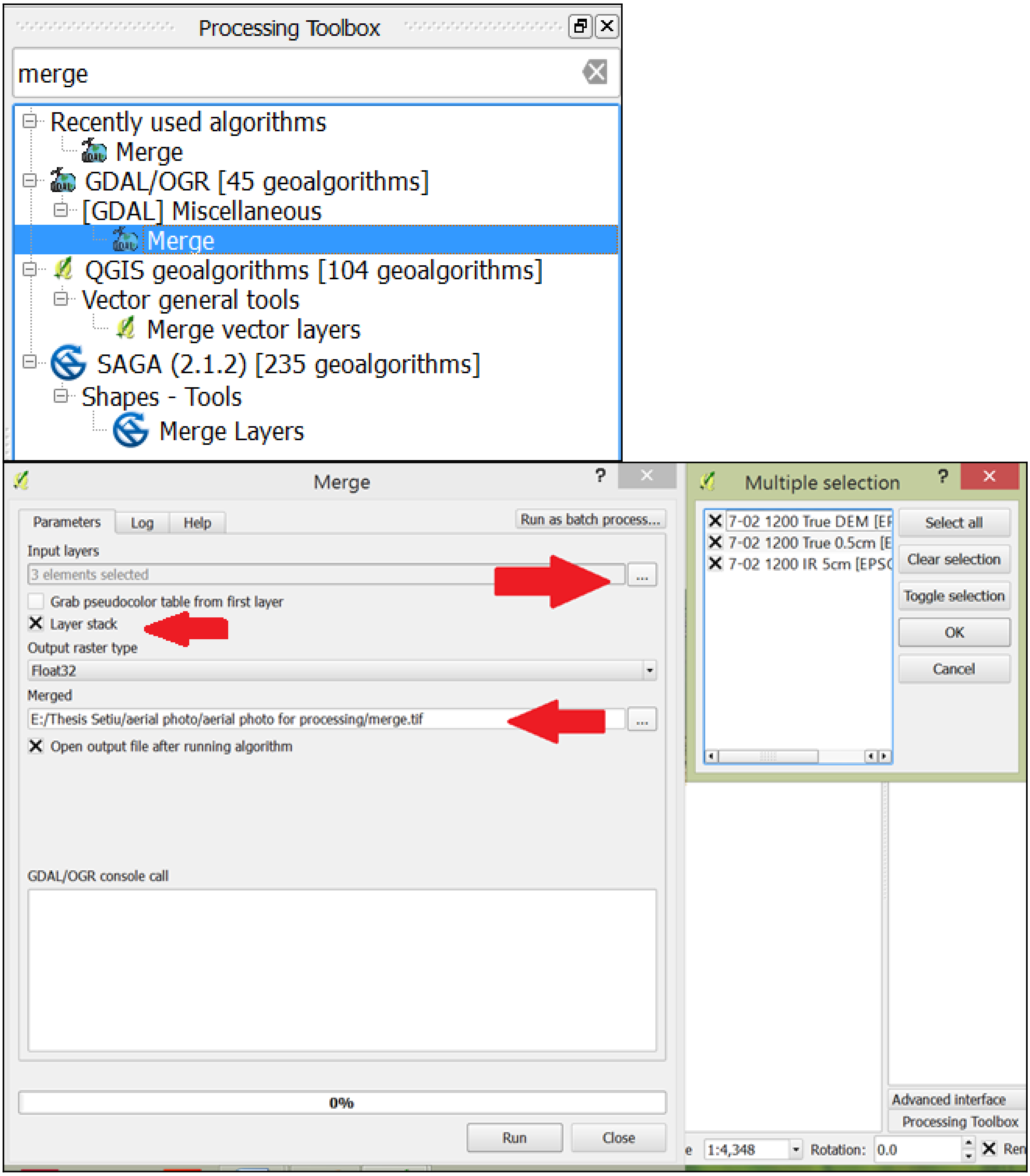

Image joining and georeferencing with satellite image

Step 36.

Build pyramid for the new merged image (as explained in the step 1)

Image joining and georeferencing with satellite image

Step 37.

Georeference the image again, but this time use the Satellite Image as the reference coordinate point. Follow the step 6-8 for this process. Build pyramid for the referenced image.

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Paralax and Invalid DEM Cropping

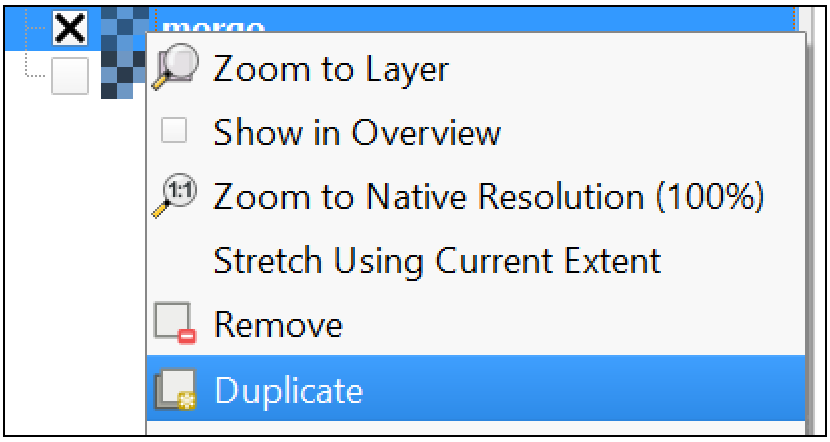
Step 38.

Open the merged and georeferenced image in the QGIS (by Add Raster Layer or ctrl-shift-R)

Paralax and Invalid DEM Cropping

Step 39.

Duplicate the image by right click on the image list, then click “Duplicate"



Paralax and Invalid DEM Cropping

Step 40.

On the merged image, right click and click “Properties”. On the tab “Style”, chose “Multiband color” as Render type. Choose Band 5-6-7 (R, G, B) for true color views. Choose “No Enhancement” for contrast enhancement, and click “Apply”.

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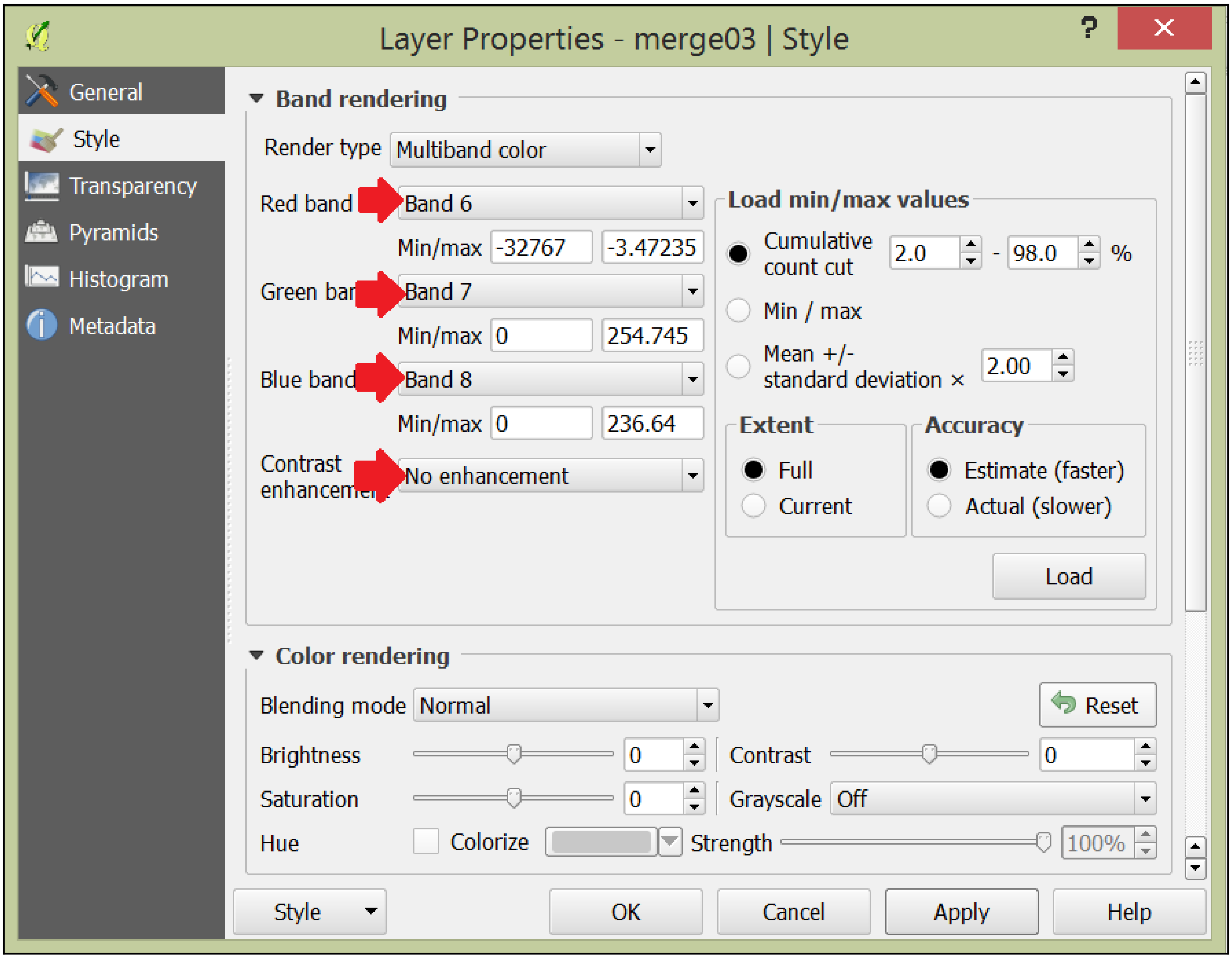

Paralax and Invalid DEM Cropping

Step 41.

On the copy of merged image, right click and click “Properties”. In the tab “Style”, chose “Singleband pseudocolor” as Render type. Choose Band 1 (DEM), put value 0-30 (to view DEM of 0 m to 30 m). Click “Classify”, then click “Apply”.

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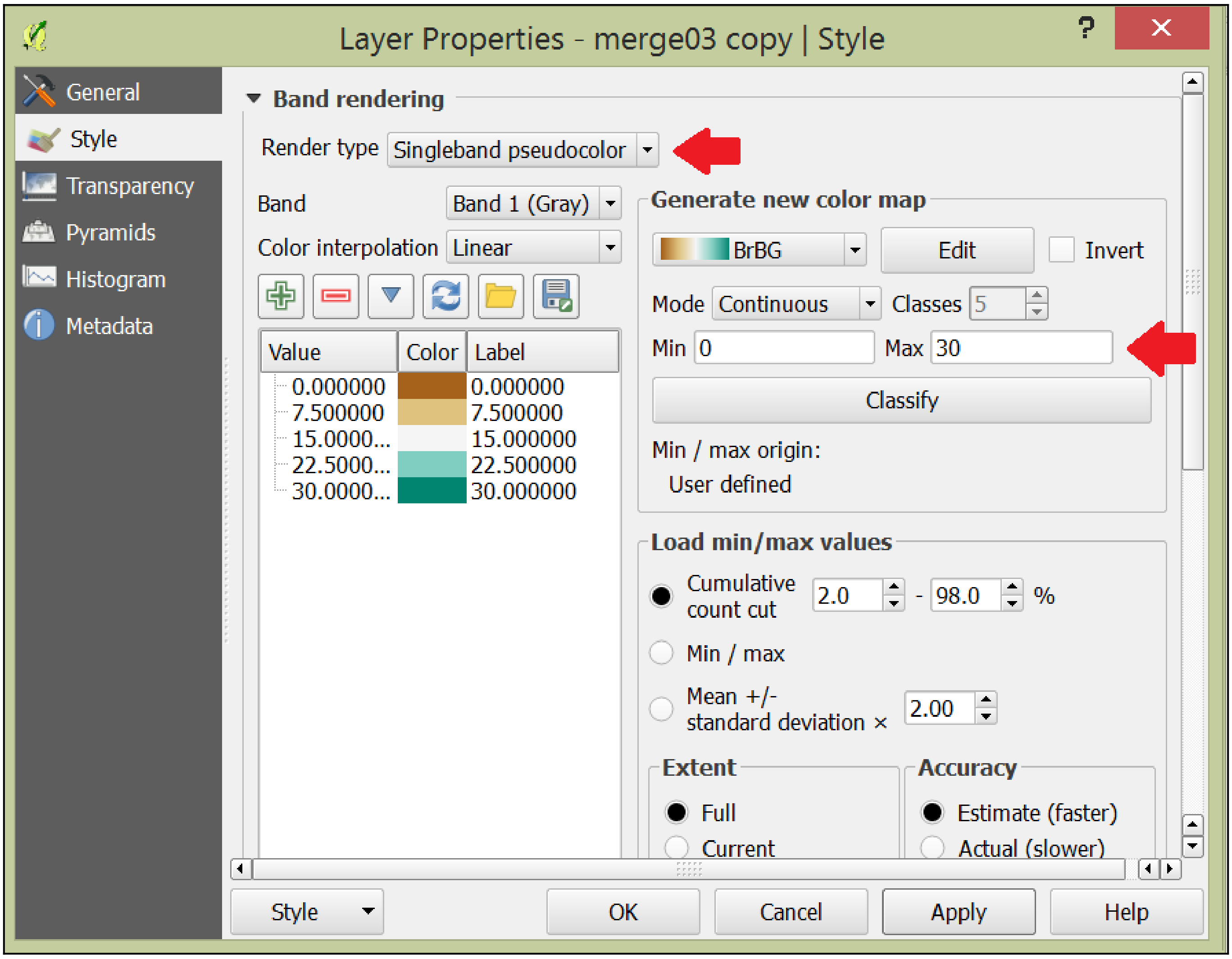

Paralax and Invalid DEM Cropping

Step 42.

Compare both image in the format true color/RGB and in the DEM, observe the parallax area (where the trees look elongated outward) and invalid DEM area. This area needs to be cropped.

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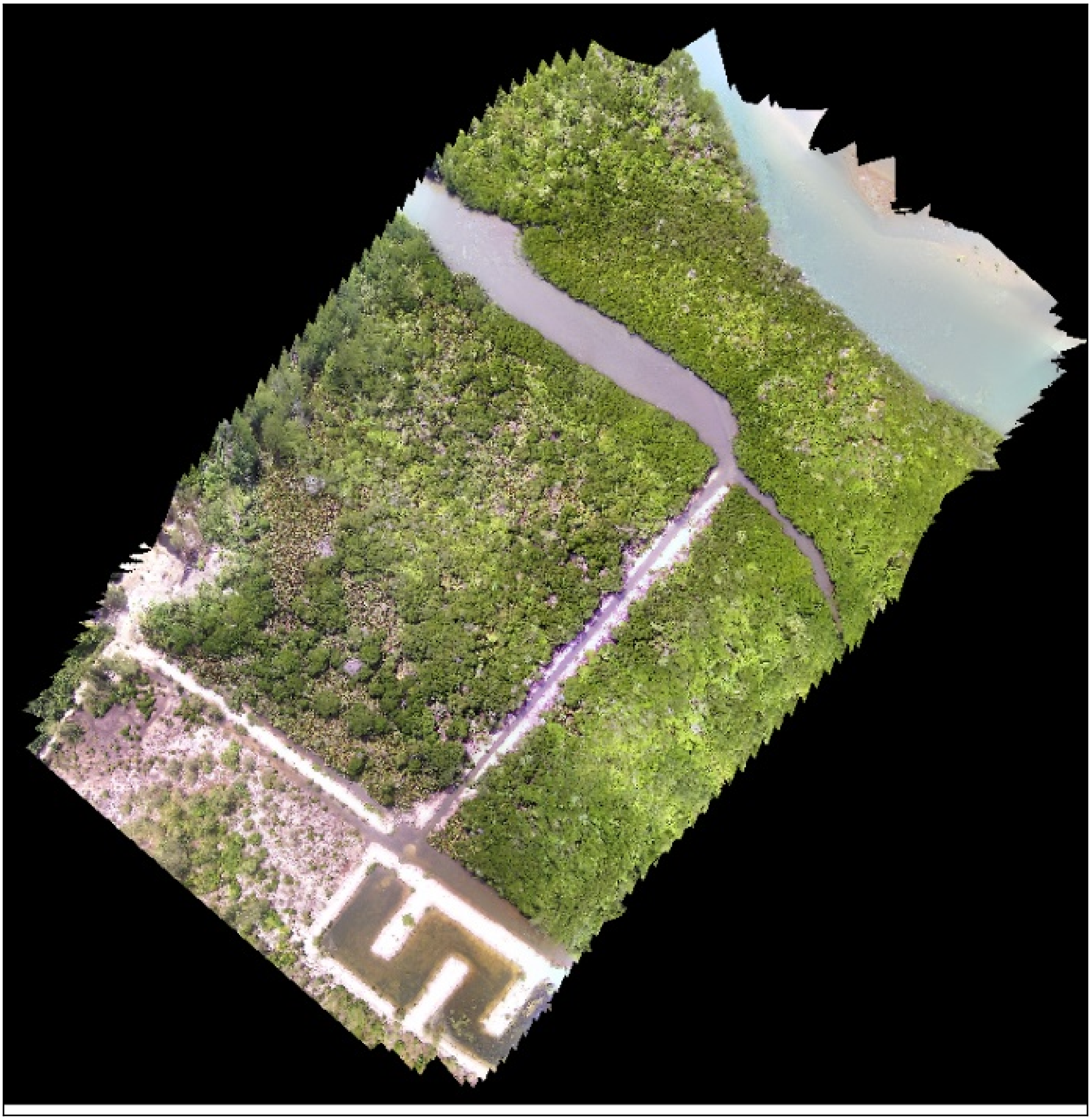

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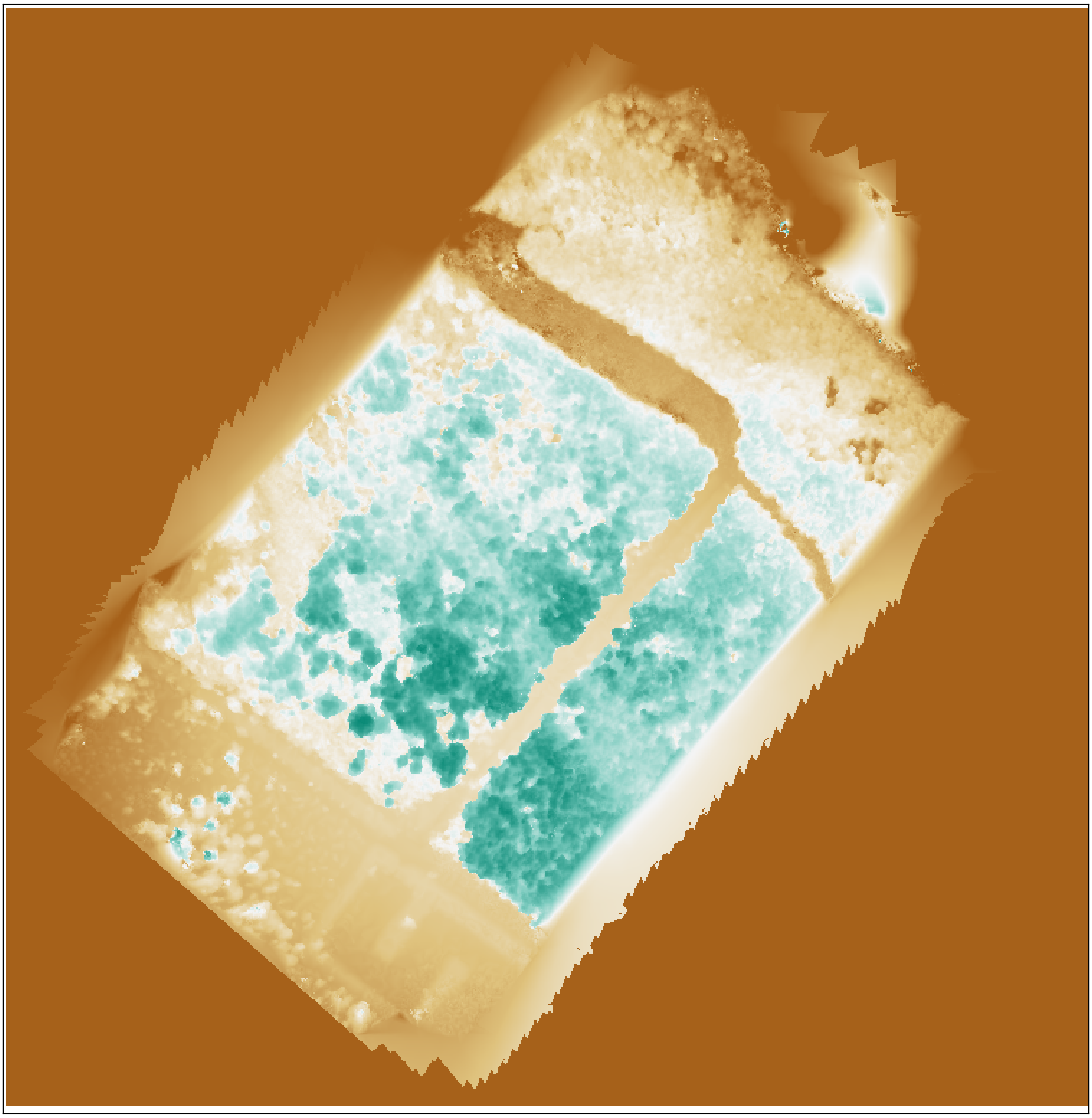

Paralax and Invalid DEM Cropping

Step 43.

On the bottom left panel, click icon “New Shapefile Layer”. In the pop-up window, click “polygon” as type, and choose the UTM Zone 48 as coordinate reference system. Click OK and give the file name (“03clip”).

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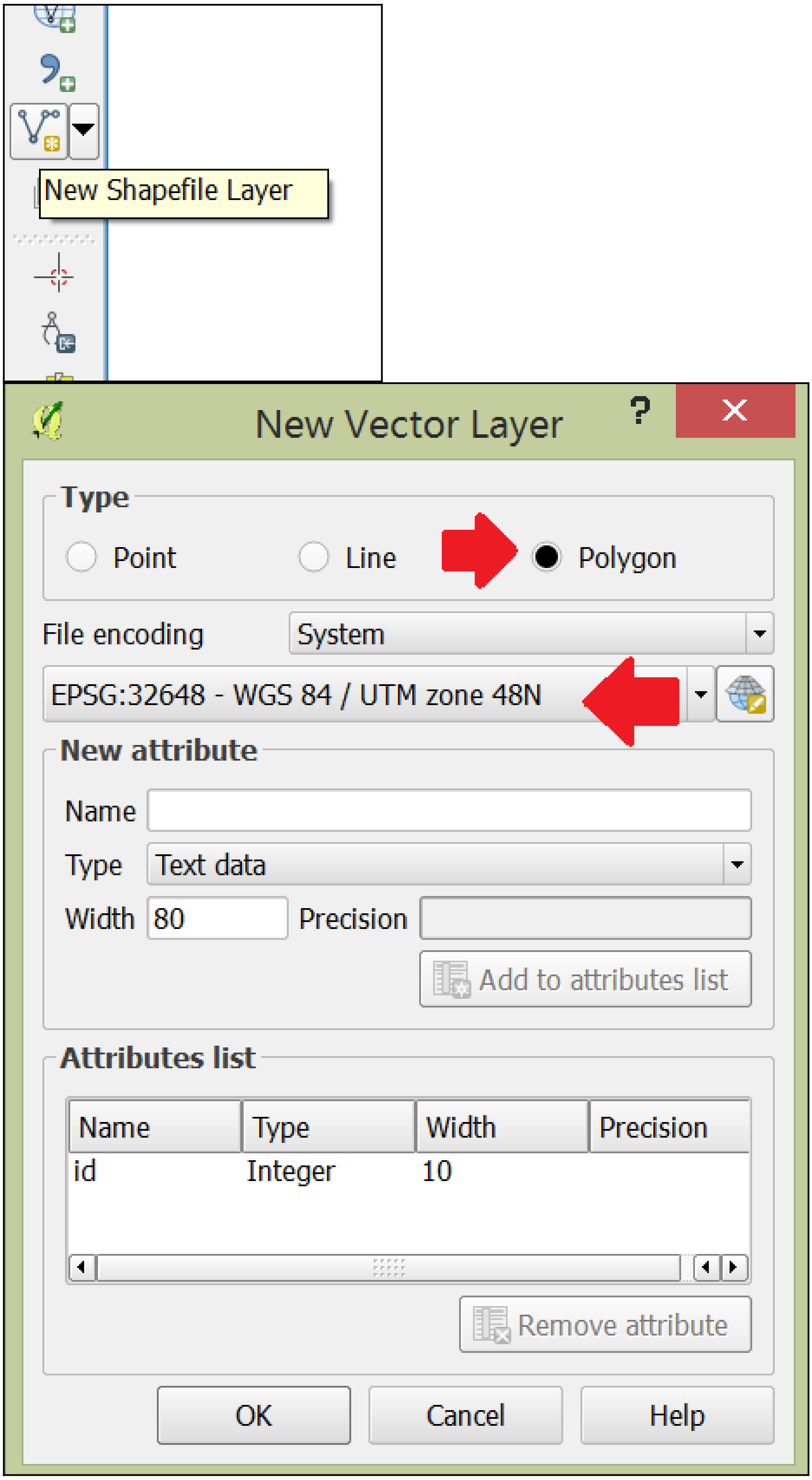

Paralax and Invalid DEM Cropping

Step 44.

Click the icon “Toggle Editing” on Digitizing Toolbar. Then click icon “Add feature”

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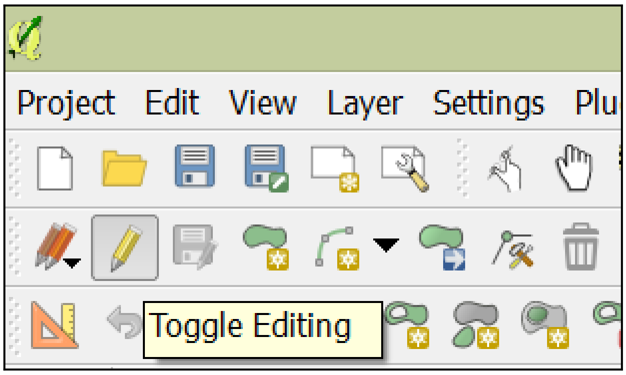

Paralax and Invalid DEM Cropping

Step 45.

Create a polygon over the image, excluding the parallax and invalid DEM area. After create the polygon, save it by clicking on “toggle editing” again

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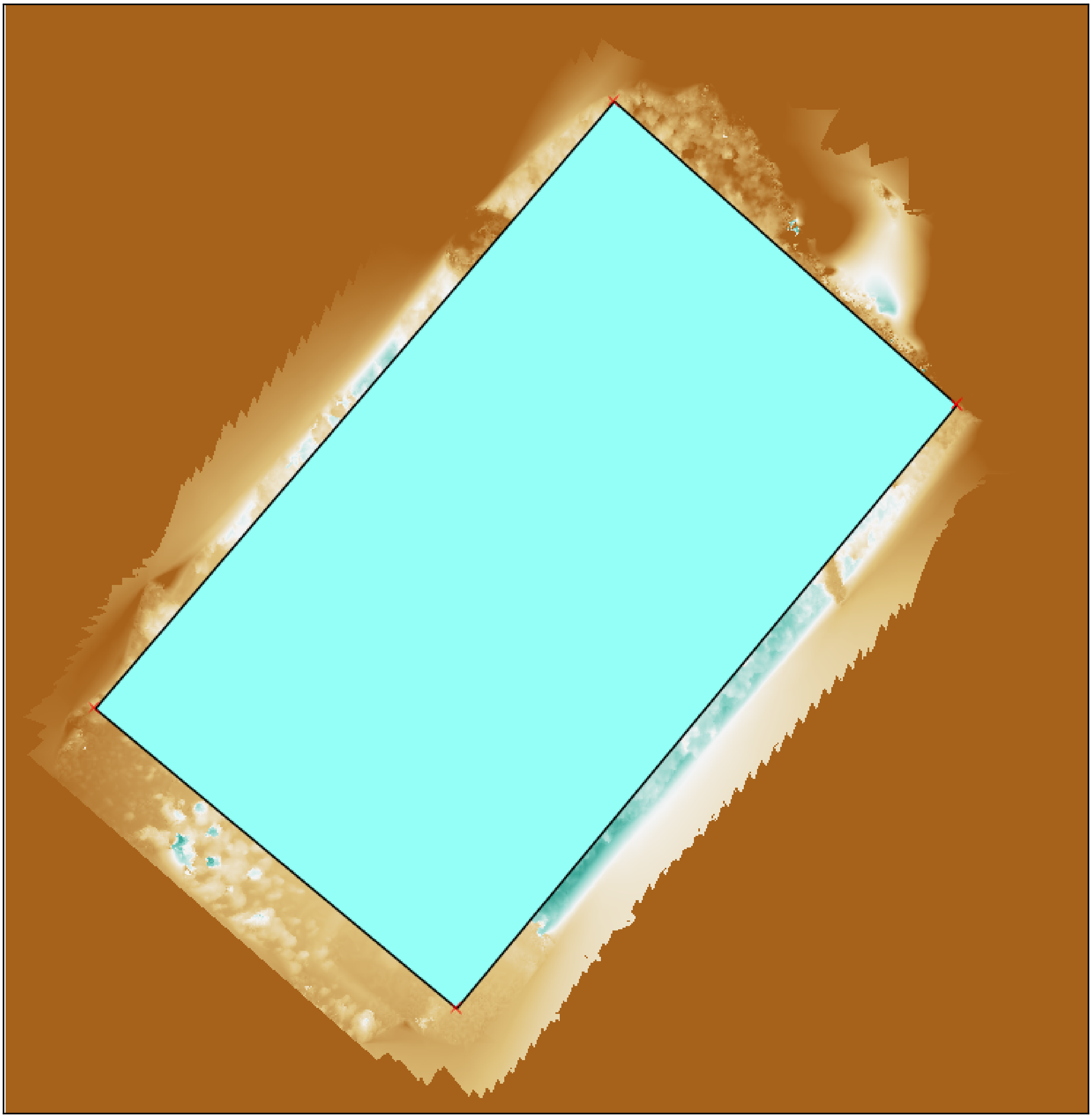

Paralax and Invalid DEM Cropping

Step 46.

Click menu “Raster – Extraction – Clipper”. On the pop-up window, put the merged image as input. Give name for the output file. On the clipping mode, choose “Mask Layer” and select the vector polygon layer that just made (“03clip”). Click OK. Wait for approximately 0.5-1 hour until the process is finished. Repeat this process to the Satellite Image, crop it with same vector file (”03clip”).

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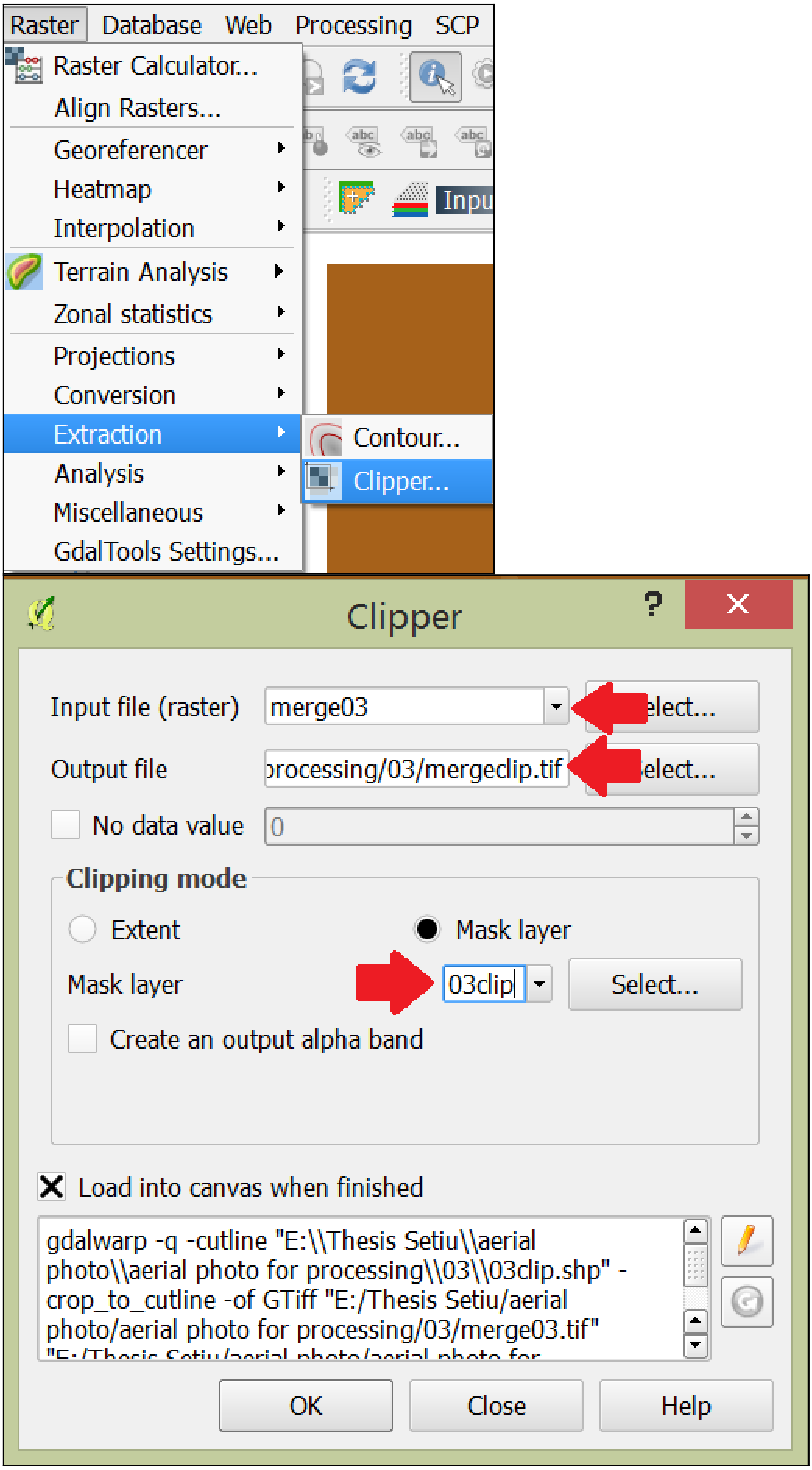

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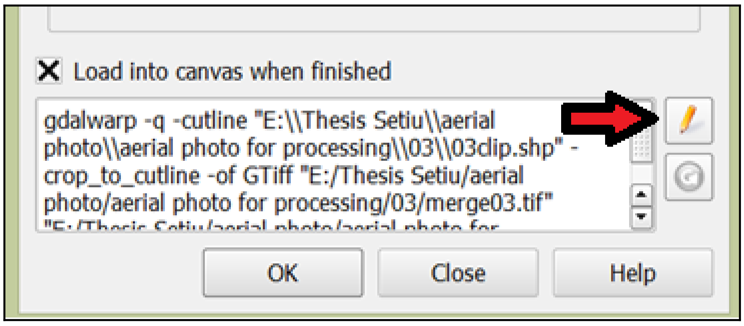
Paralax and Invalid DEM Cropping

Step 47.

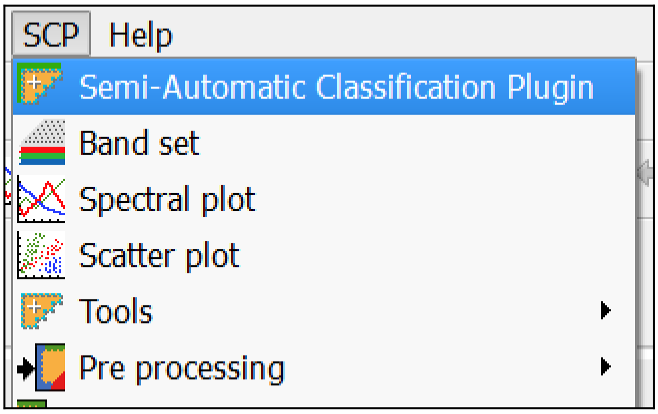
(Optional, only need to be applied for a large image) To make the clipping process faster, click edit button on the Clipper Window and add this text to the end of script: --config GDAL_CACHEMAX 1000 -wm 1000. This will increase the usage of cache memory to 1000Mb. Increase this cache memory for faster process.



ROI creation

Step 48.

Complete and original tutorial of SCP Plugin is available in this link
http://semiautomaticclassificationmanual-v4.readthedocs.io/en/latest/Tutorials.html.
Click menu “Plugins – Manage and Install Plugin”. Scroll to find Semi-Automatic Classification Plugin and click “Install Plugin”. Menu “SCP” will appear, open it and click “Semi-Automatic Classification Plugin” to activate the plugin



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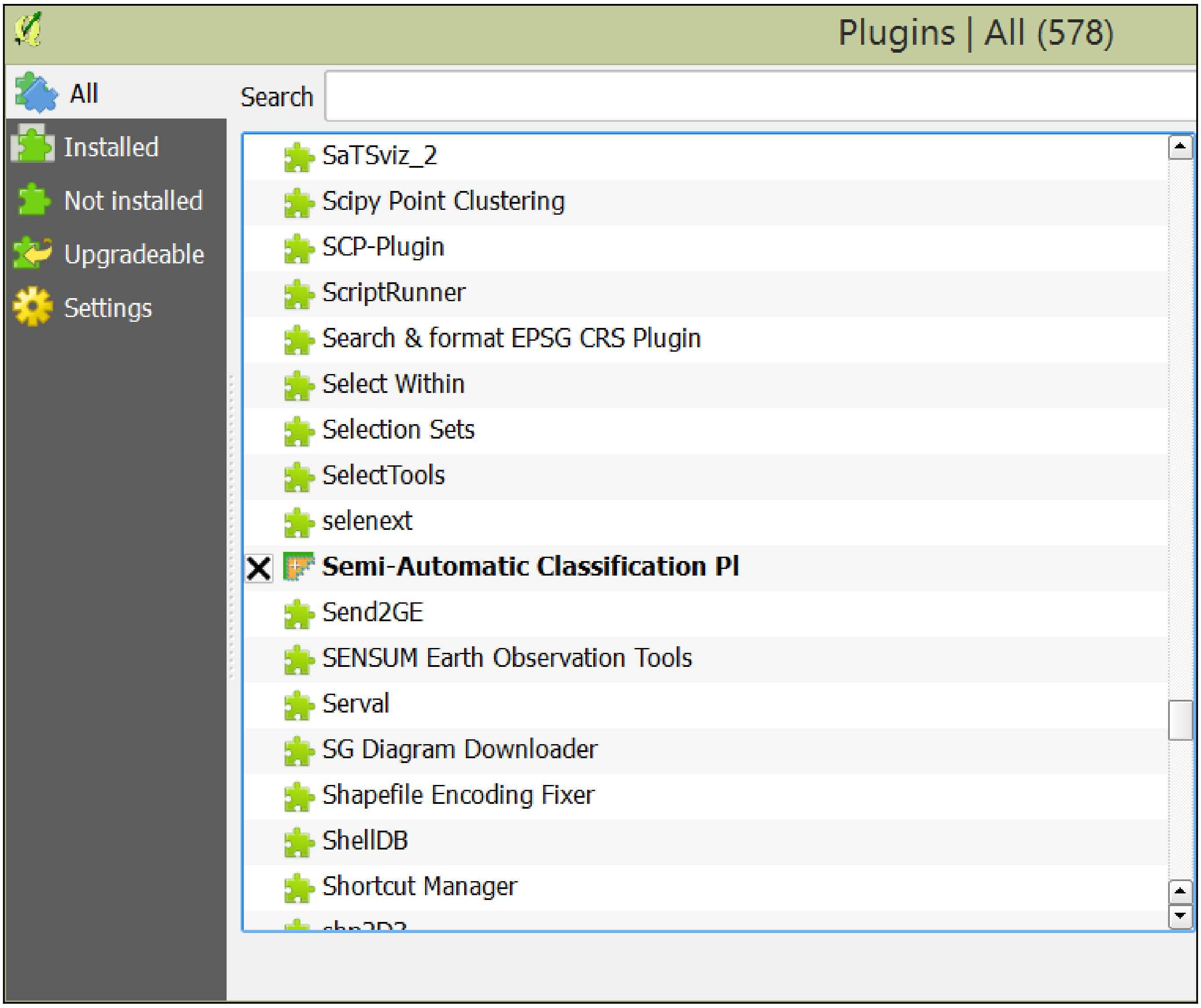

ROI creation

Step 49.

Open the cropped or clipped raster image from previous section (Open raster layer or Ctrl-Shift-R)

ROI creation

Step 50.

Load the image to plugin. Click the refresh button in SCP toolbar, and chose the raster file name (in this case it is “03clip”)

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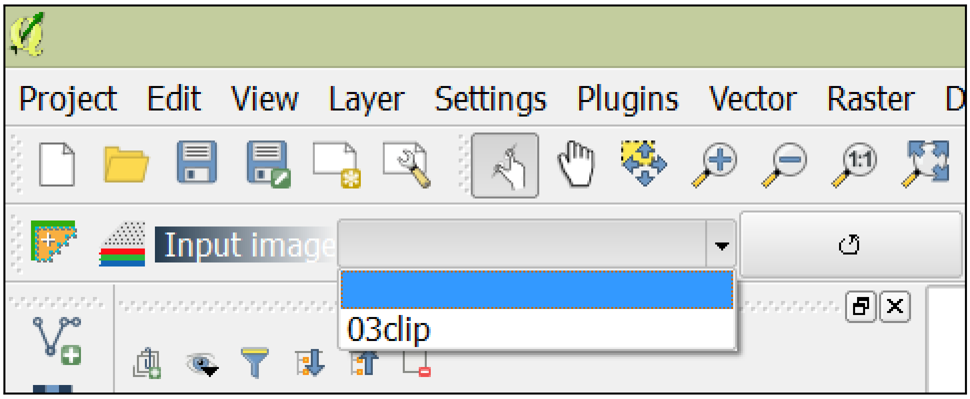

ROI creation

Step 51.

Open the “SCP: ROI creation” Panel (located on the right side of the window). Click “New shp” and give a name to the shapefile (in this case it is “traindroneS”). Choose the class ID (as example “1”) and give the class name (as example “water”). Un-click the “Add. Sig list”

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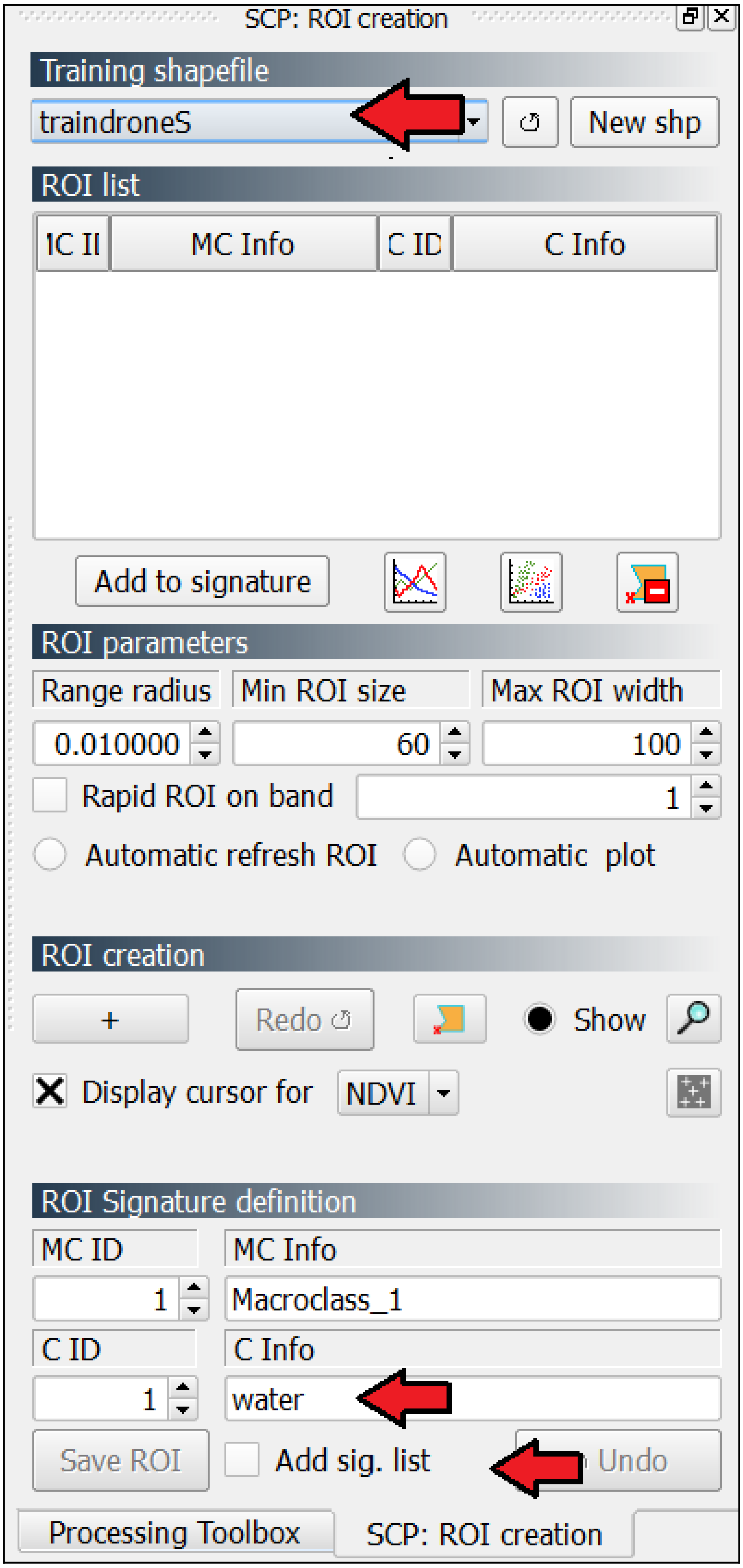

ROI creation

Step 52.

Click the “Create ROI Polygon”, and draw the polygon over the image. Additionally, you could make sure the polygons have same size by using a measuring tool. Then click “Save ROI”

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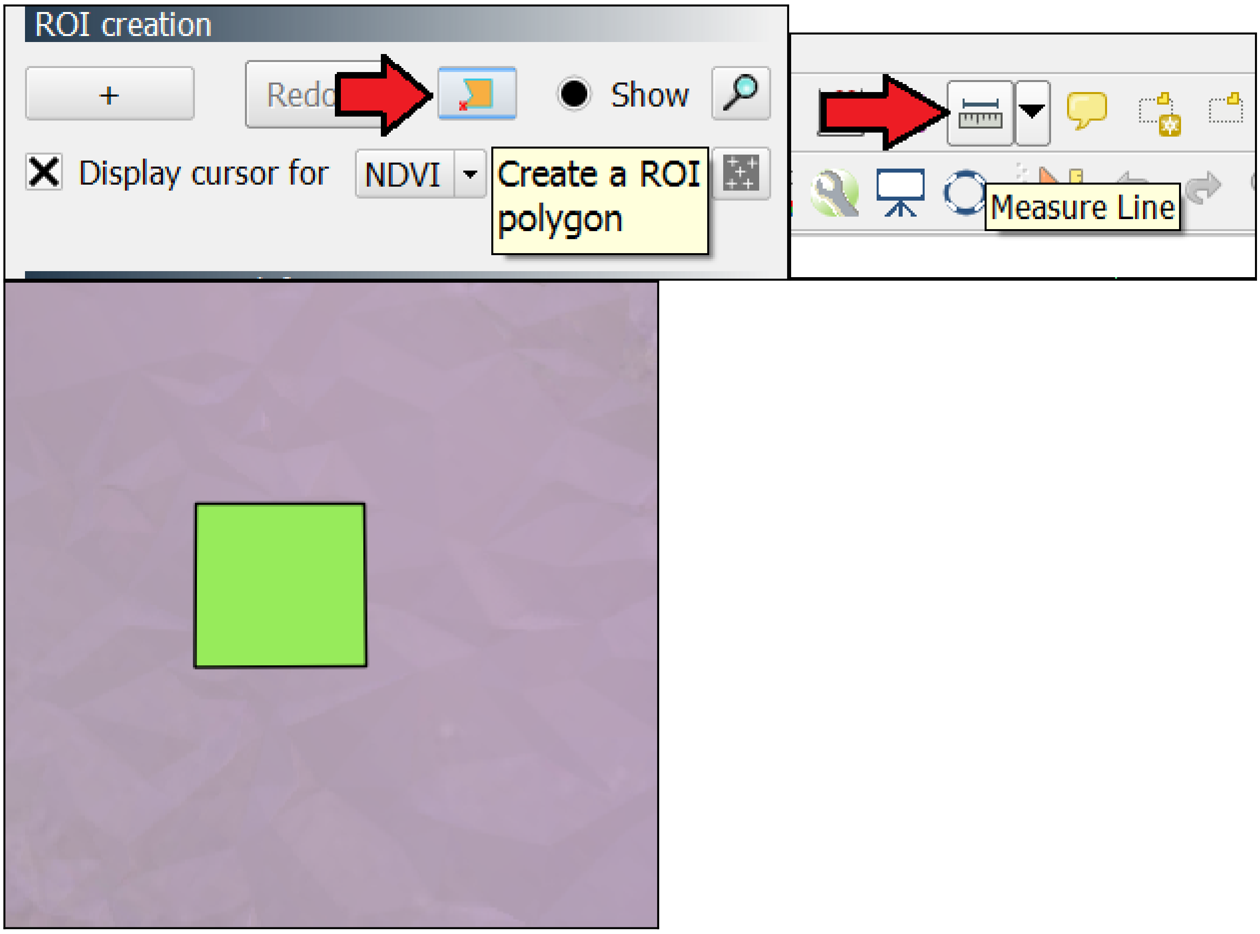

ROI creation

Step 53.

Repeat the polygon creating process until every class covered by same number of polygons with same coverage area. Use information from field surveys data and photographs. Load the plot data by click menu “Layer – Add Layer – Add delimited Text Layer”. On the opened window, click data contain Adult Tree (“AT plot.csv”) and click OK. The plot data will load into the diplay. Use icon “identify features” to click on the plot and to see the information.

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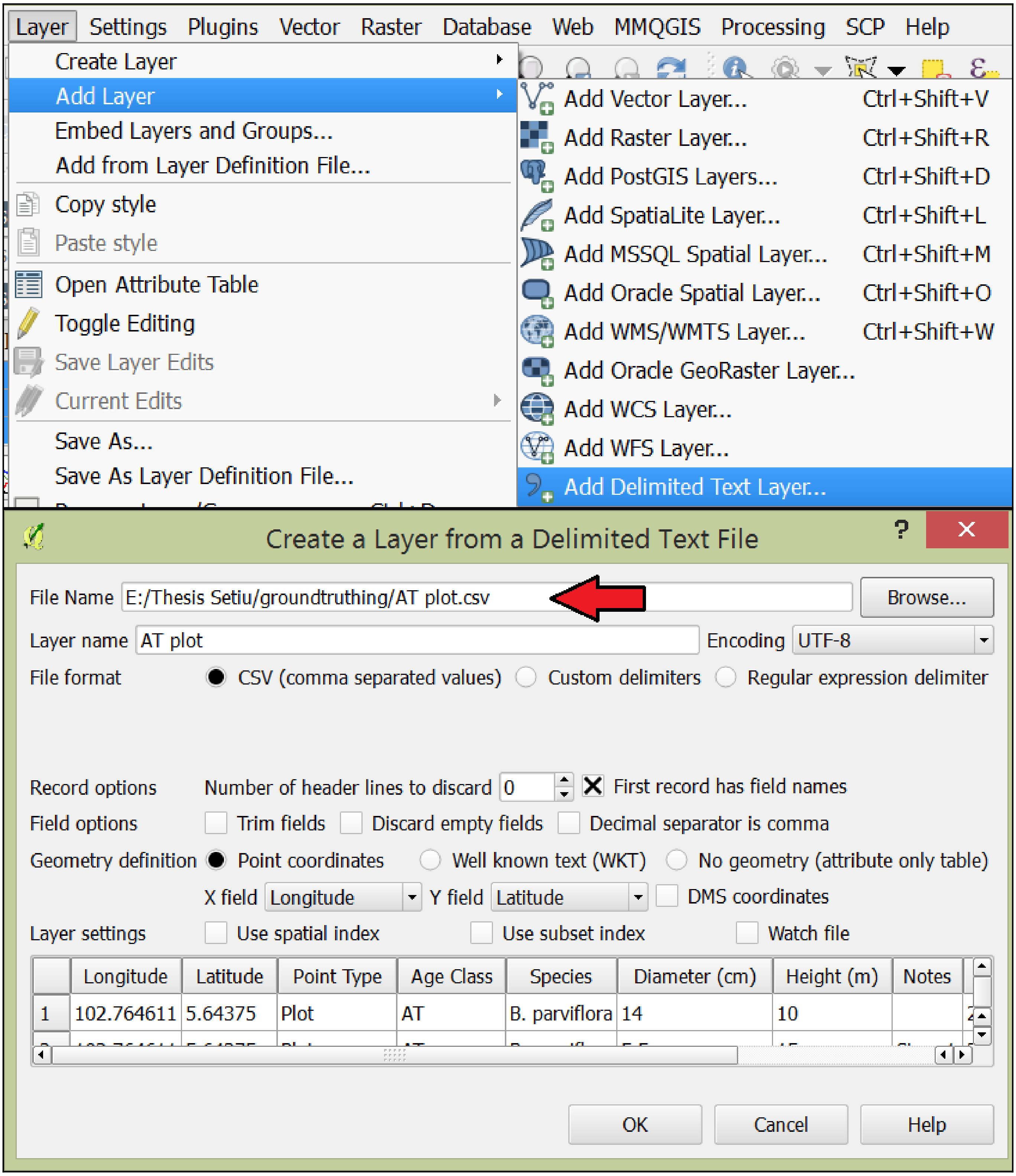

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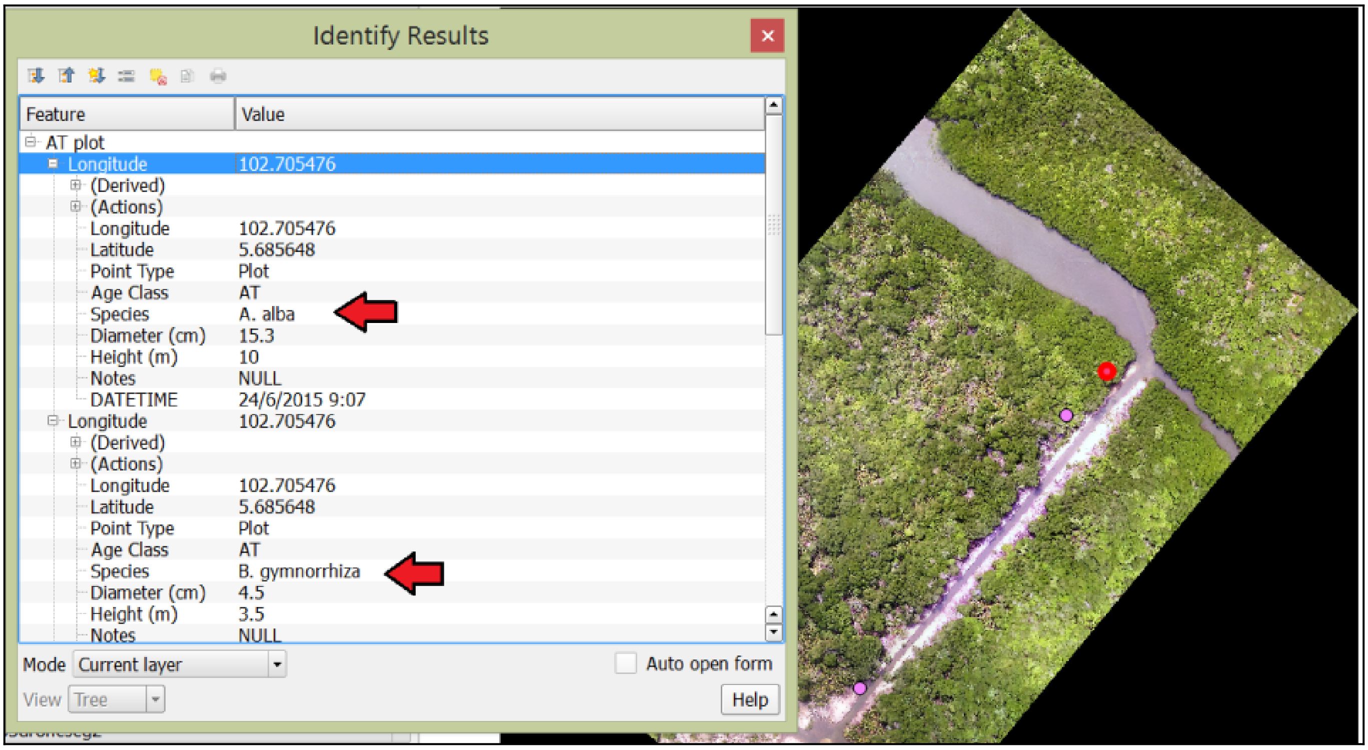
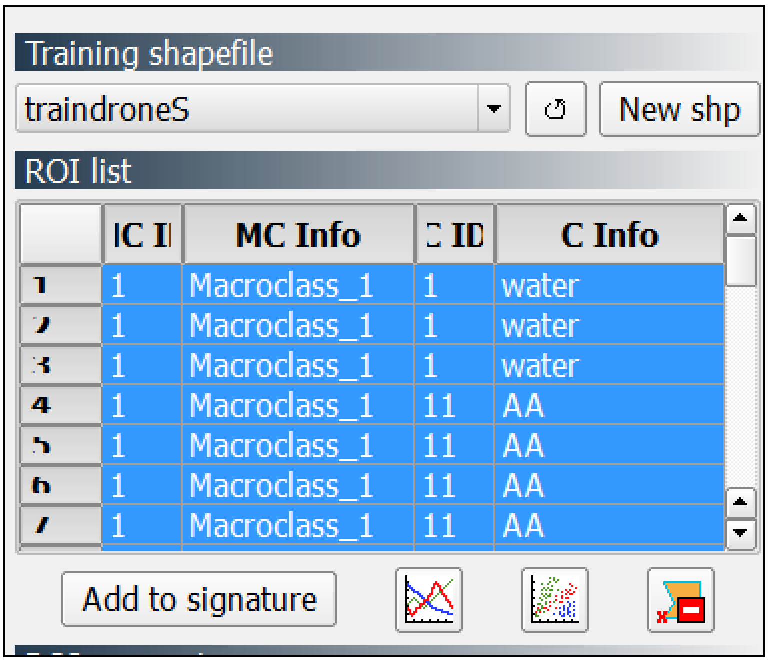


ROI creation

Step 54.

After ROI polygons are created, select all the ROIs and click “Add to signature”. Wait for 20-30 minutes for drone image and 2-3 minutes for satellite image.



ROI creation

Step 55.

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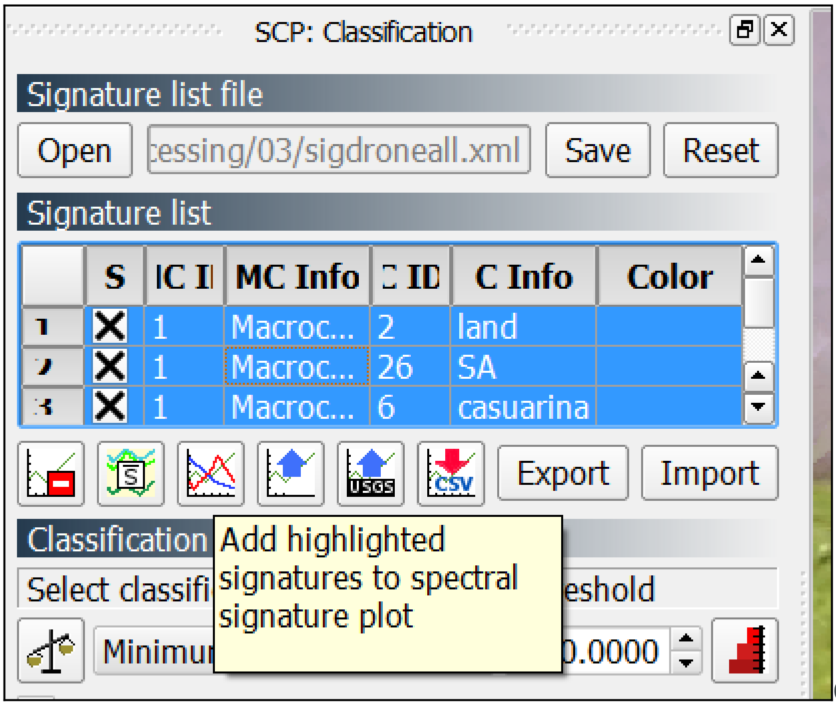

On the "SCP: Classification" Panel (on the left side) the signatures will appear. Click "Save" and give a name to the signature file ("sigdroneall"). Select all signatures and click icon "Create signature plot" .

ROI creation

Step 56.

Review the signature, by zooming on the plot. Click on the tab "Signature file" and "Signature distance" to evaluate separation between classes. This overall signature will be used to write manual rule-set. Close the SCP Plot.

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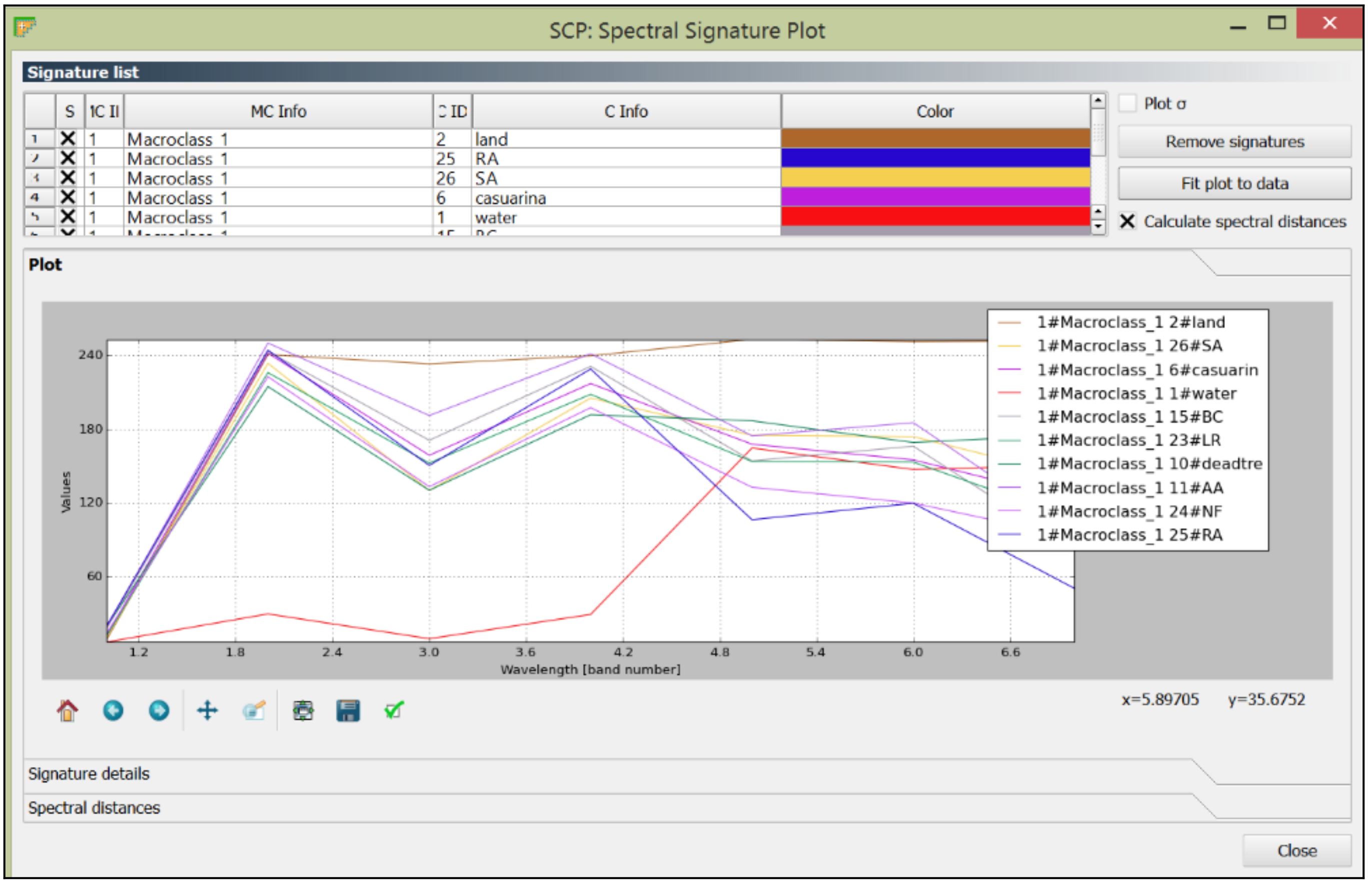

ROI creation

Step 57.

On the Layers panel, right click on “traindroneS” and click “Save as”. On the opened window, give a name to the file (“traindroneS1A”) and click OK. Repeat the process to 4 more time to create files labeled up to “traindroneS5A”.

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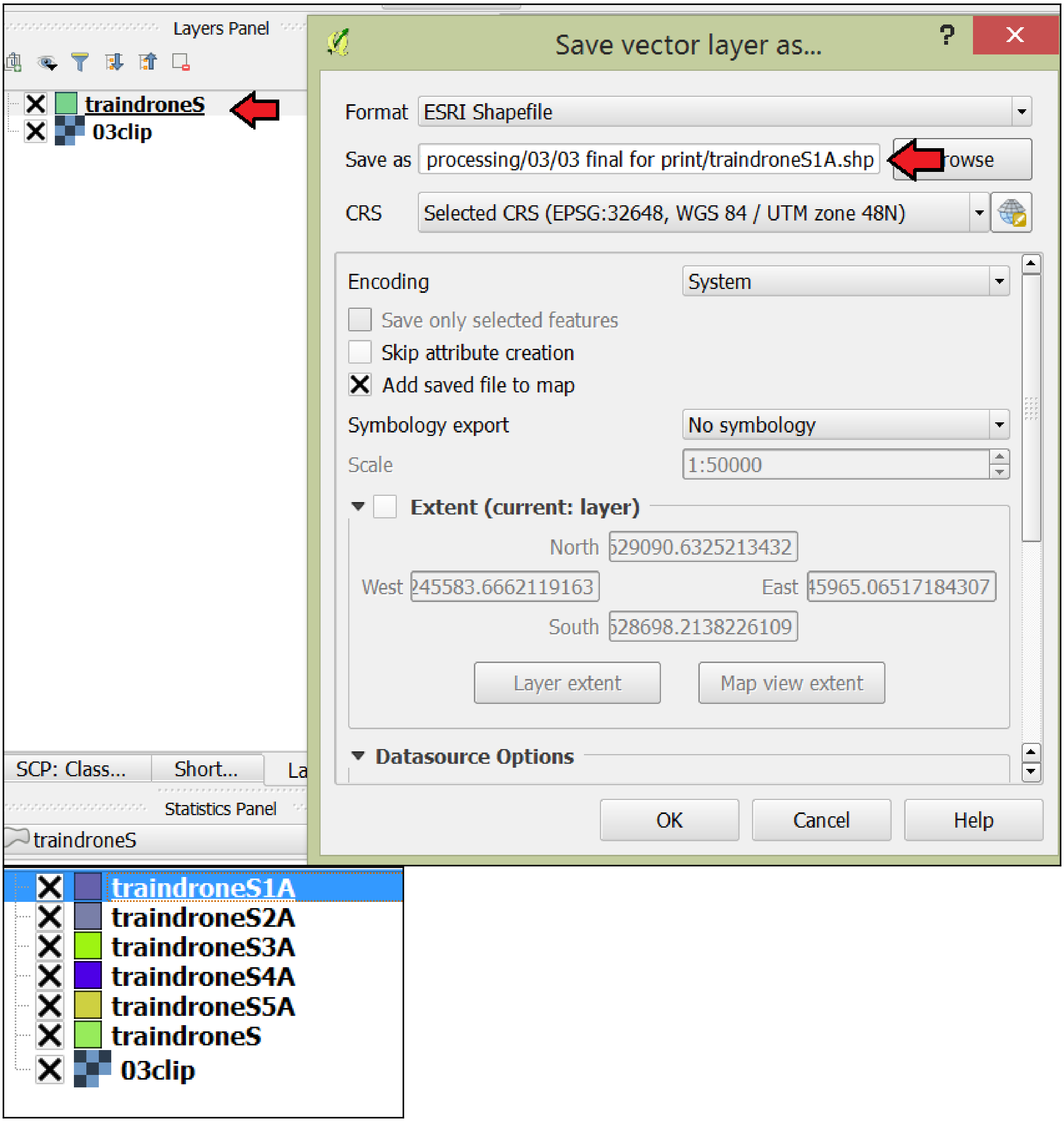

ROI creation

Step 58.

Click menu “Vector – Research Tools – Random Selection Within Subsets”.

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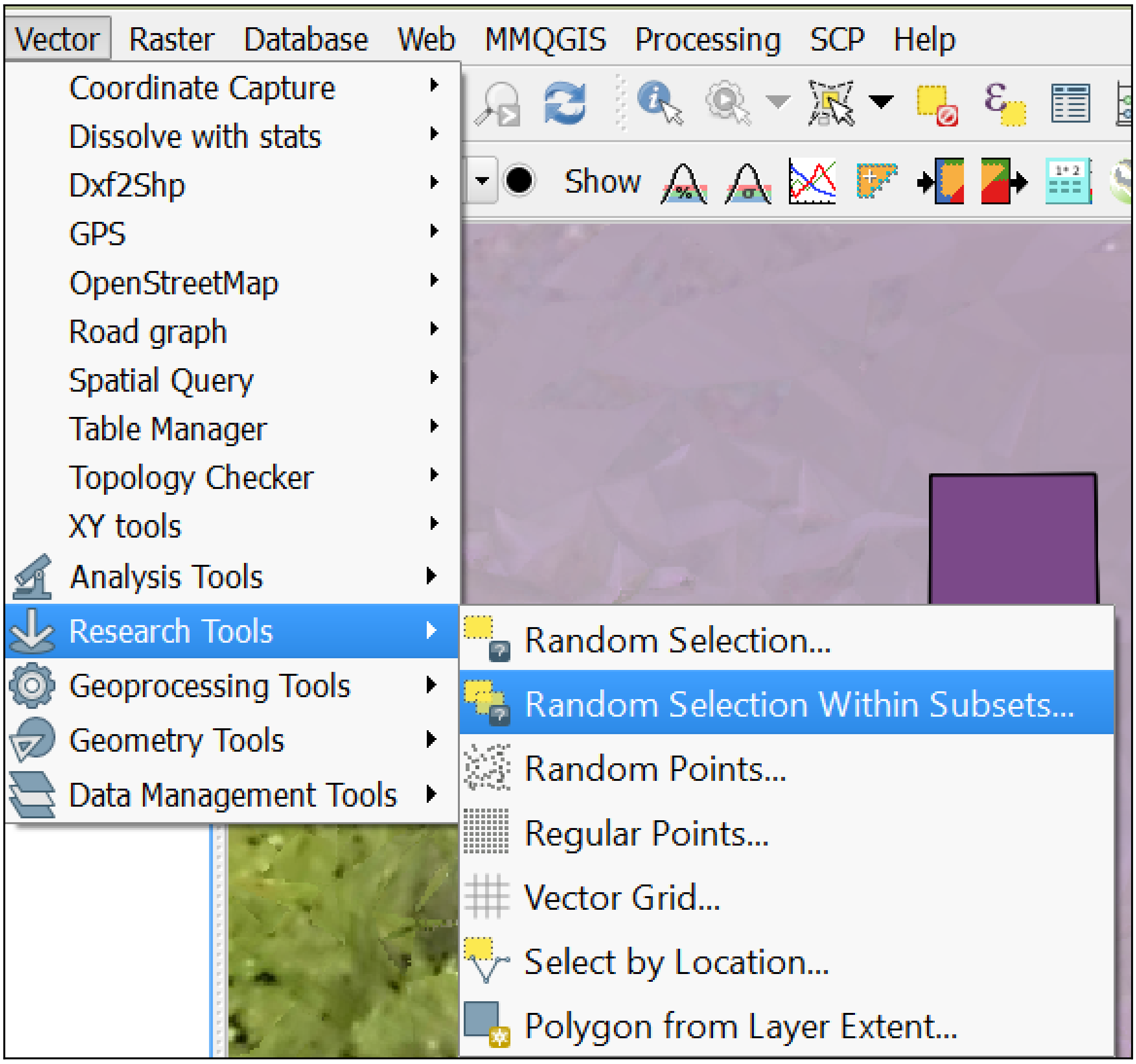

ROI creation

Step 59.

On the opened window, choose “traindroneS1A” as Input Vector Layer. Choose “C_ID” as unique ID field. Choose 50% for percentage of features. Click “OK”. Half of the polygons per class is selected and will be colored yellow on the display.

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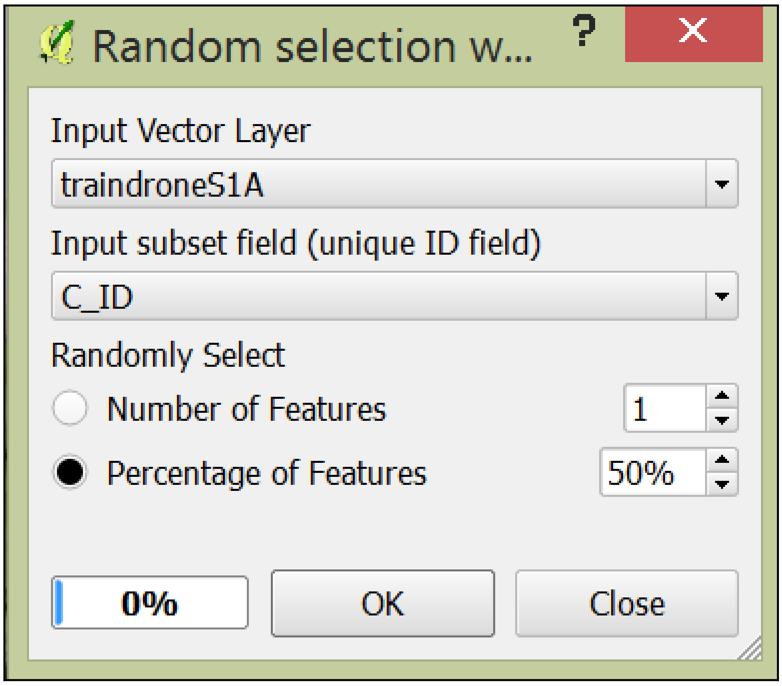

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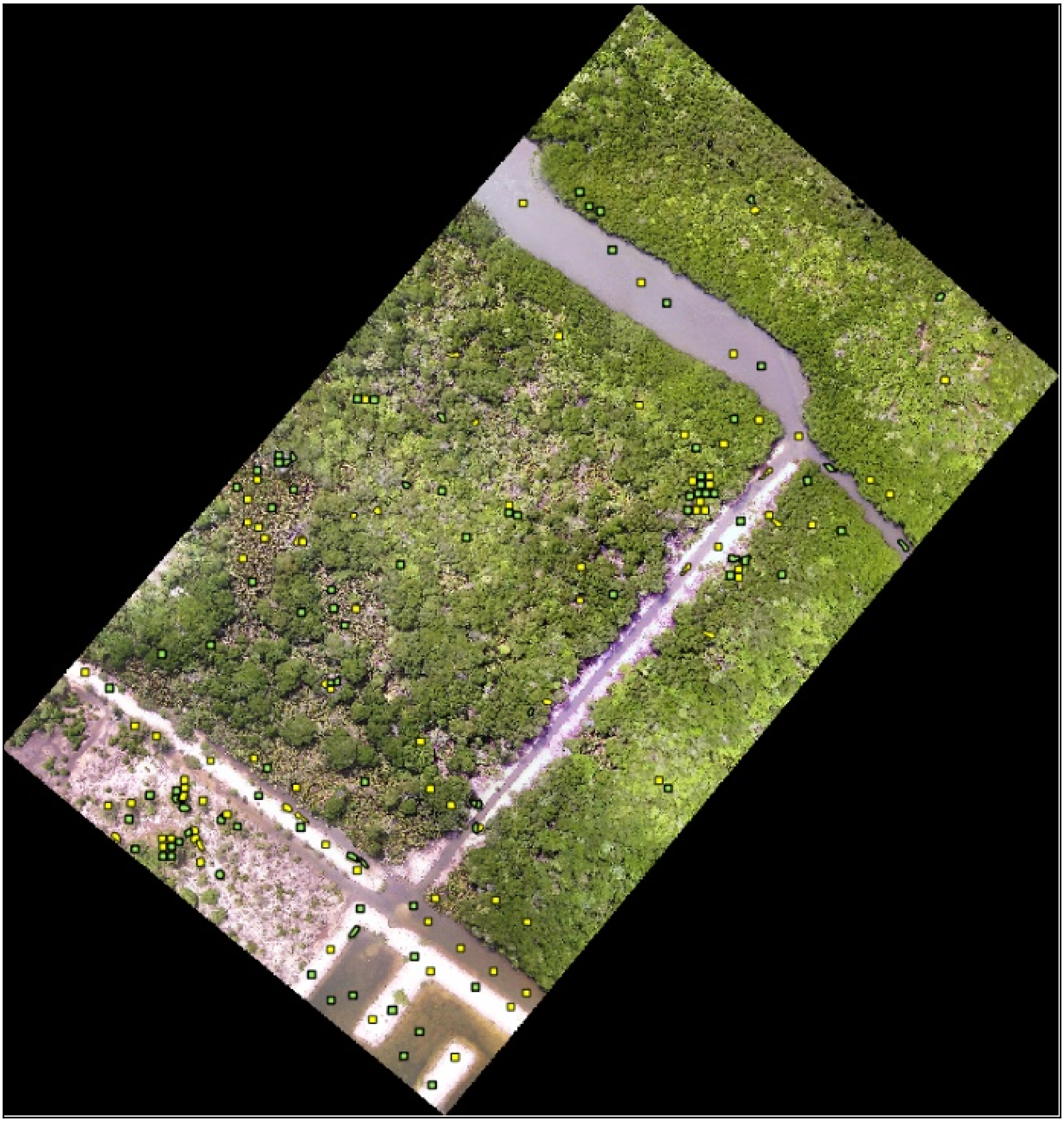

ROI creation

Step 60.

Right click on “traindroneS1A” in layer panel and click “Save as”. Give the file name “traindroneS1B”. Click “Save only selected features” and click OK. This new shapefile will be loaded into the display

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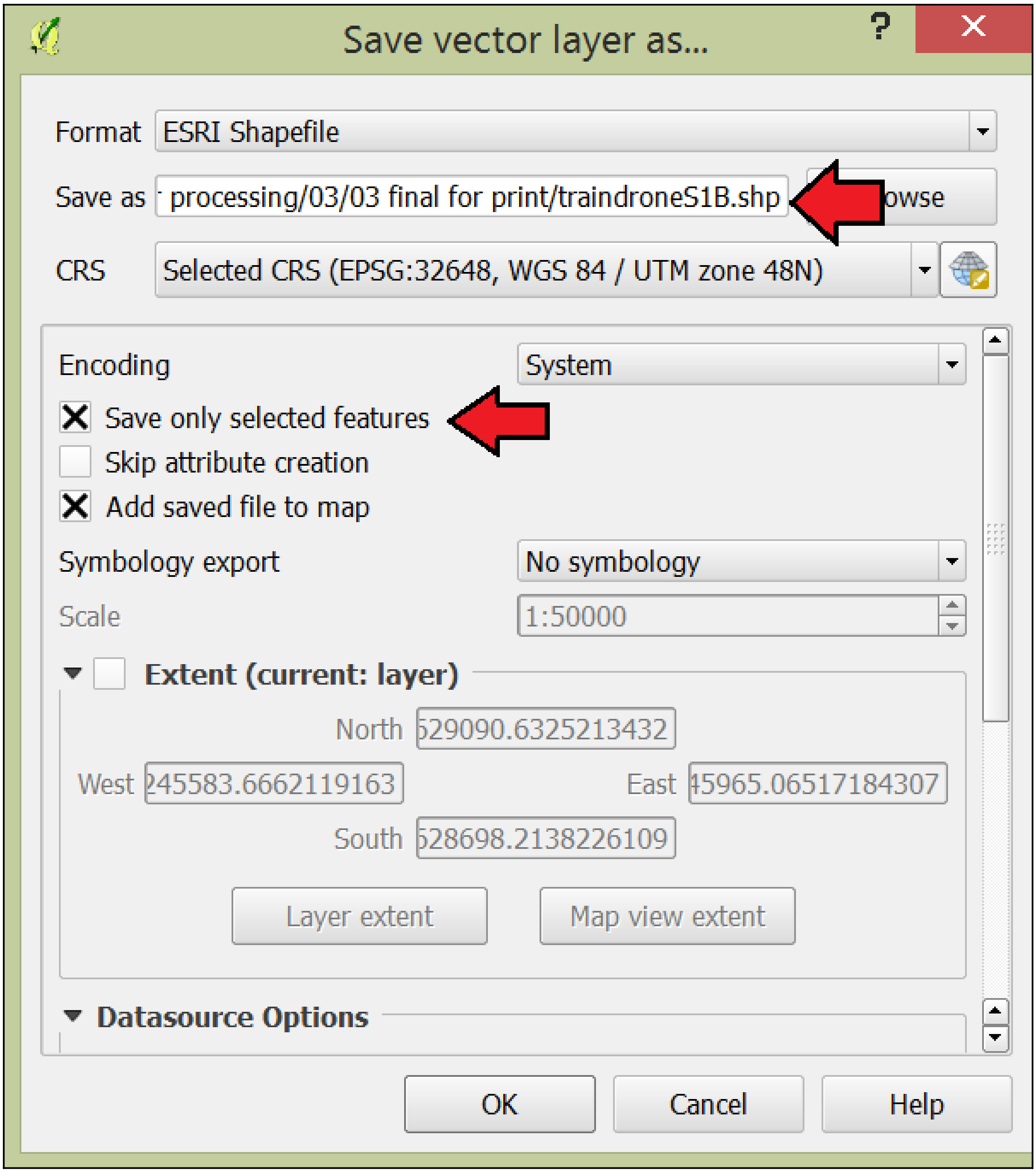

ROI creation

Step 61.

Click again on “traindrone1A” and click icon “toggle editing” on the digitizing toolbar. Click icon “delete” to delete the selected polygons. Then click again on the icon “toggle editing” to save the change. Now a pair of training sites is finished. Repeat the process to “traindrone2A” to create “trainedrone2B” and so on.

Segmentation

Step 62.

This part is based on this tutorial
http://wiki.awf.forst.uni-goettingen.de/wiki/index.php/Object-based_classification_(Tutorial)
Open clipped/cropped raster image in QGIS (Add raster layer/ctrl-shift-R).

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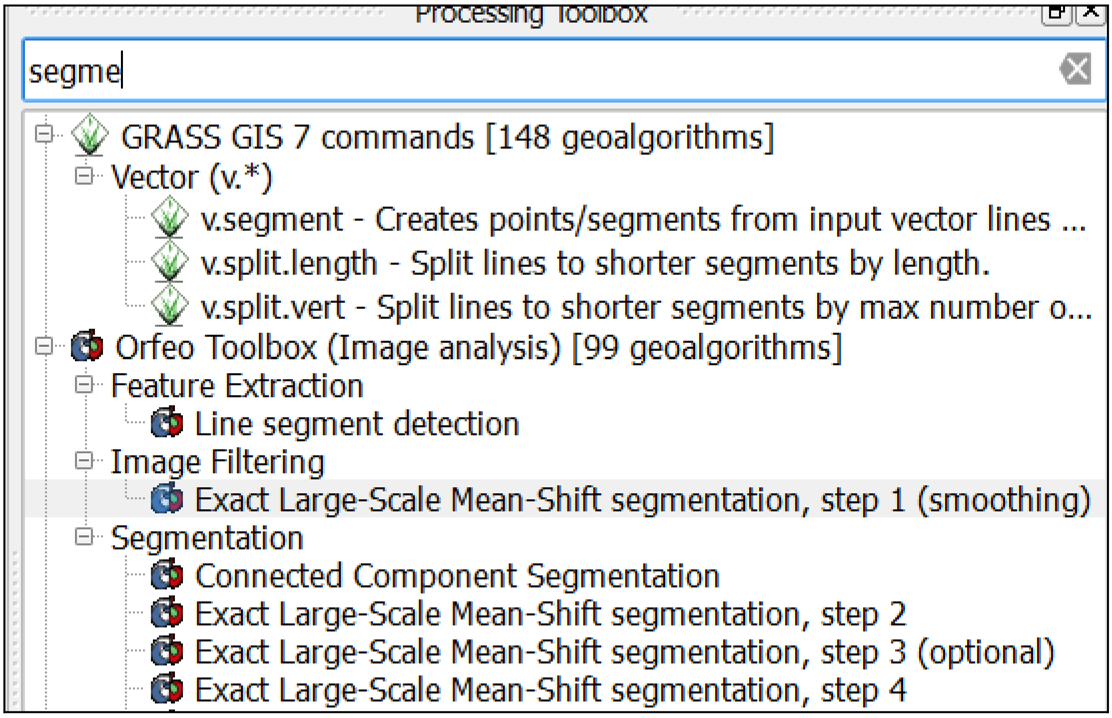
Segmentation

Step 63.

On the Processing Toolbox panel, type “segmentation”. Click on the “Exact Large-Scale Mean-Shift segmentation, step 1”.



Segmentation

Step 64.

On the opened window, put the raster file name (“03clip”) and put the Available RAM (Mb) based on the computer’s capacity. The standard was 128 Mb, but higher RAM allocation will make the process runs faster. Click “Run”. Wait 3-4 hours until the process is finished, then a result called “Filtered output” will appears on the Layers panel.

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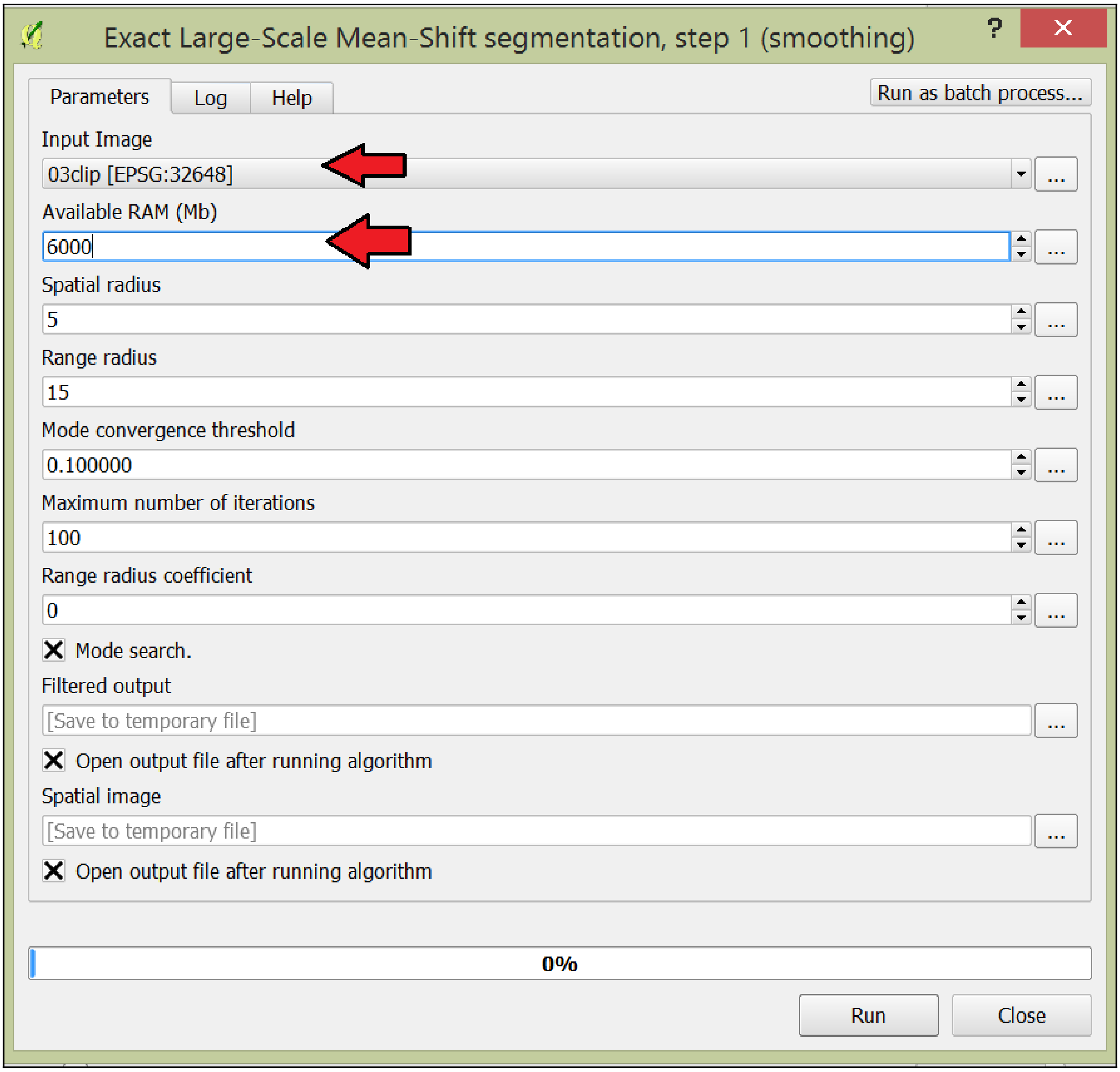

Segmentation

Step 65.

Click “Exact Large-Scale Mean-Shift segmentation, step 2”. Put the “Filtered Output” as filtered image. Then click Run. Wait around 1 hour until the process is finished, then a result called “Output image” will appear on the Layers panel.

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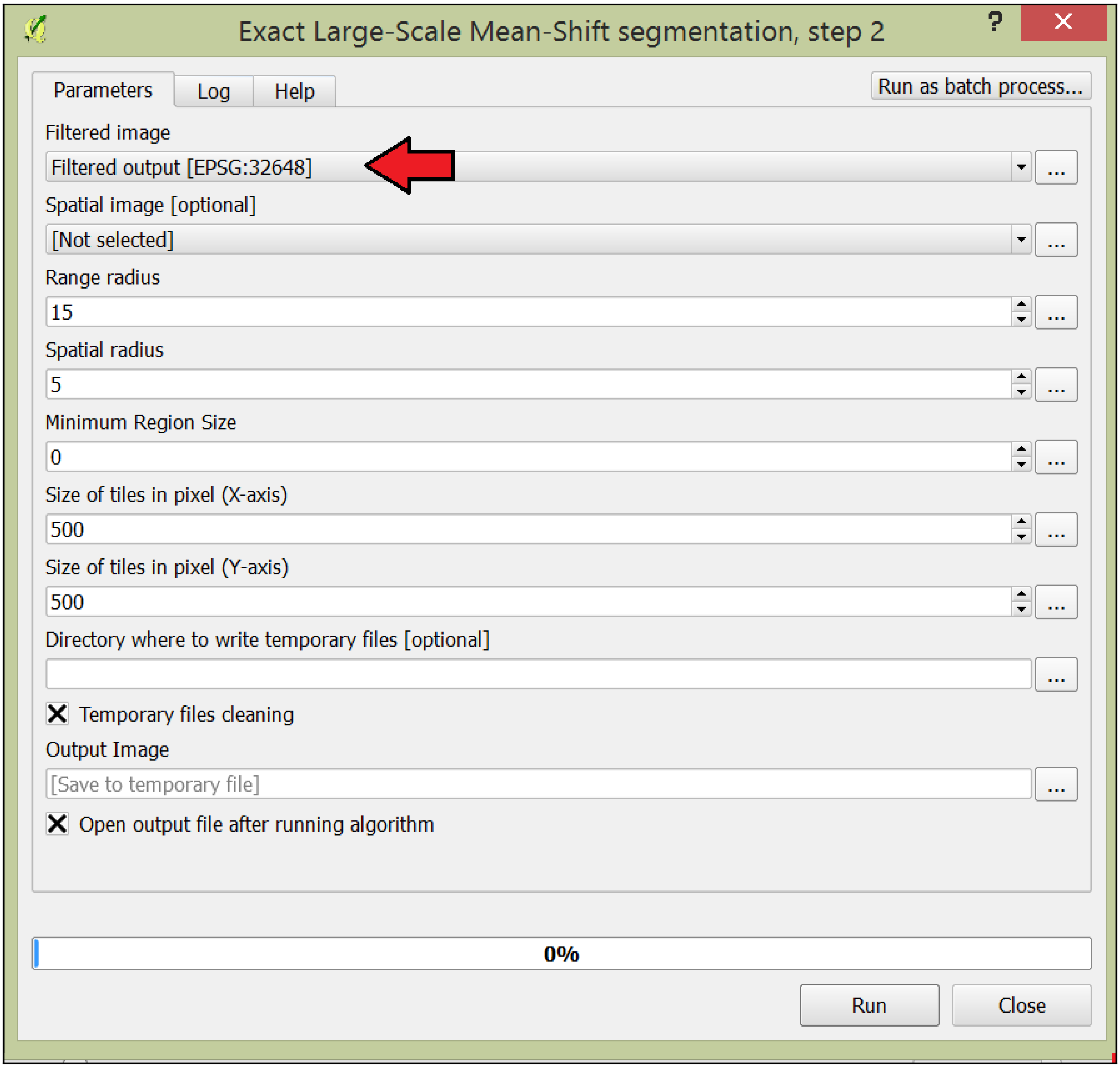

Segmentation

Step 66.

Click “Exact Large-Scale Mean-Shift segmentation, step3”. Put the “03clip” as Input image and “Output image” as segmented image. Then click “Run”. Wait around 1 hour until the process is finished, then a result called “Output image” will appears on the Layers Panel. As there is 2 “Output image”, delete the previous one from step 2.

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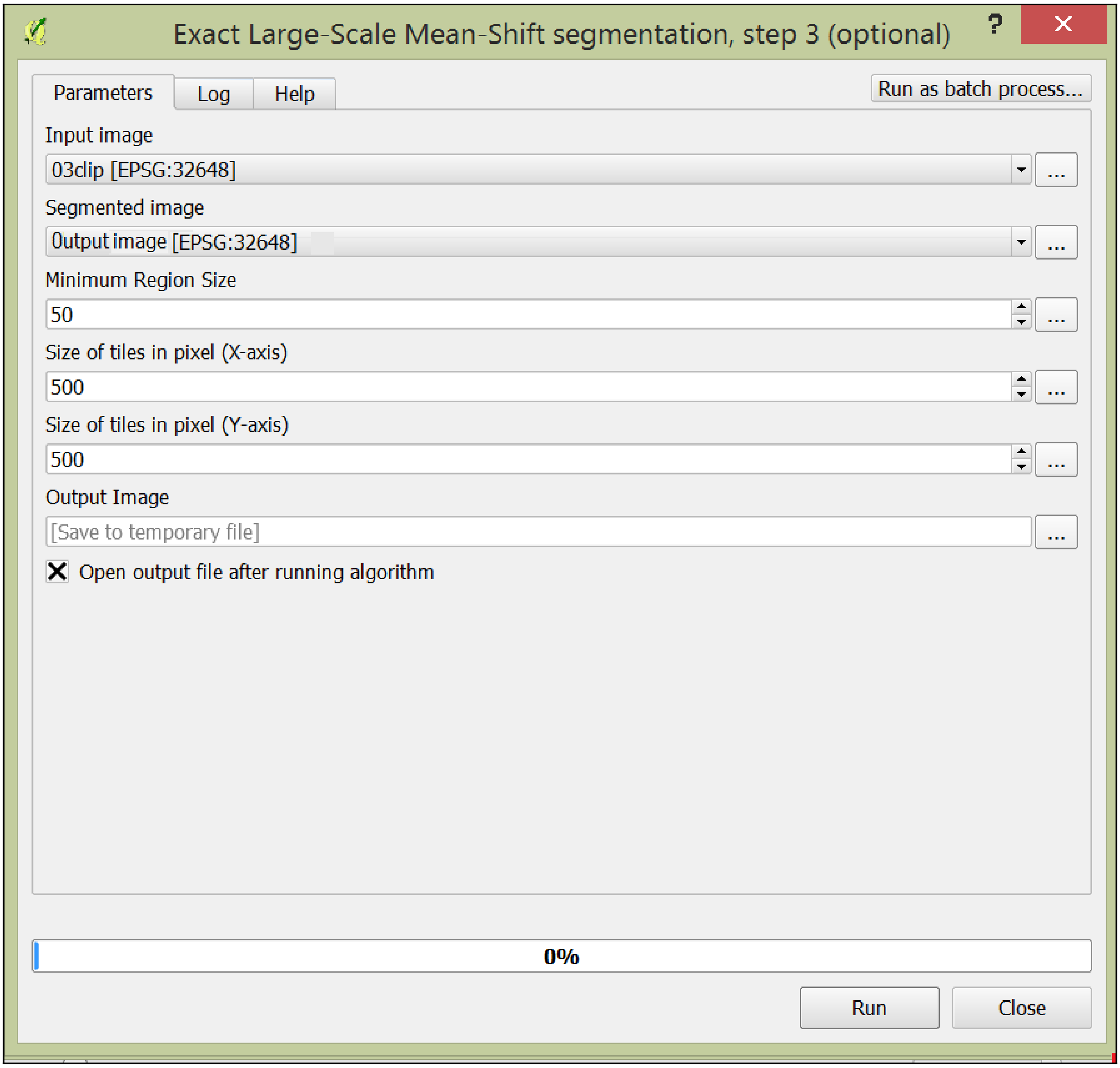

Segmentation

Step 67.

Click “Exact Large-Scale Mean-Shift segmentation, step3”. Put the “03clip” as Input image and “Output image” as segmented image. Give the file name for segmentation result (“03droneseg”). Then click “Run”. Wait around 2 hours until the process is finished. Open the resulting segmentation file (Open vector layer/ctrl –shift-V).

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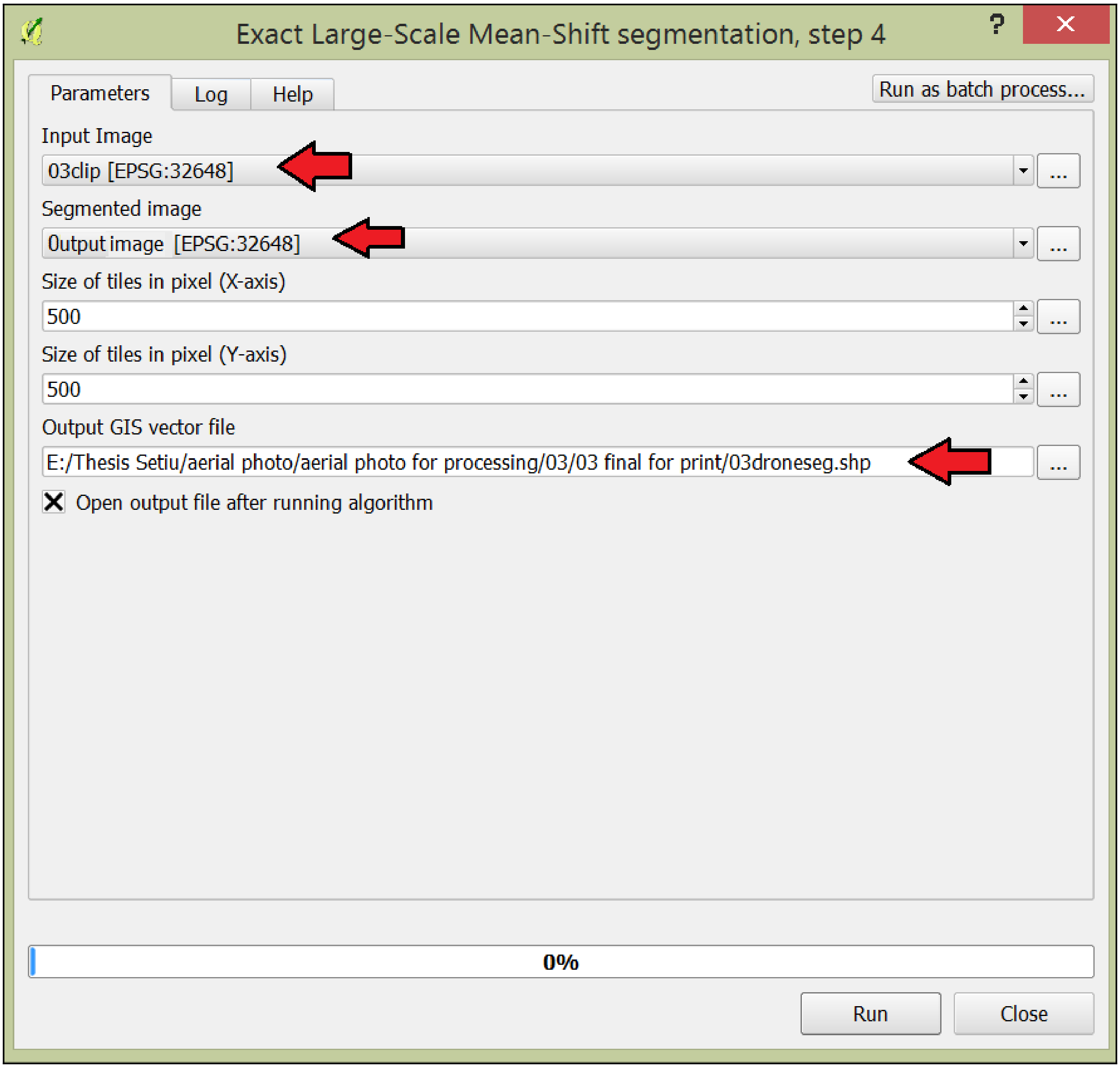

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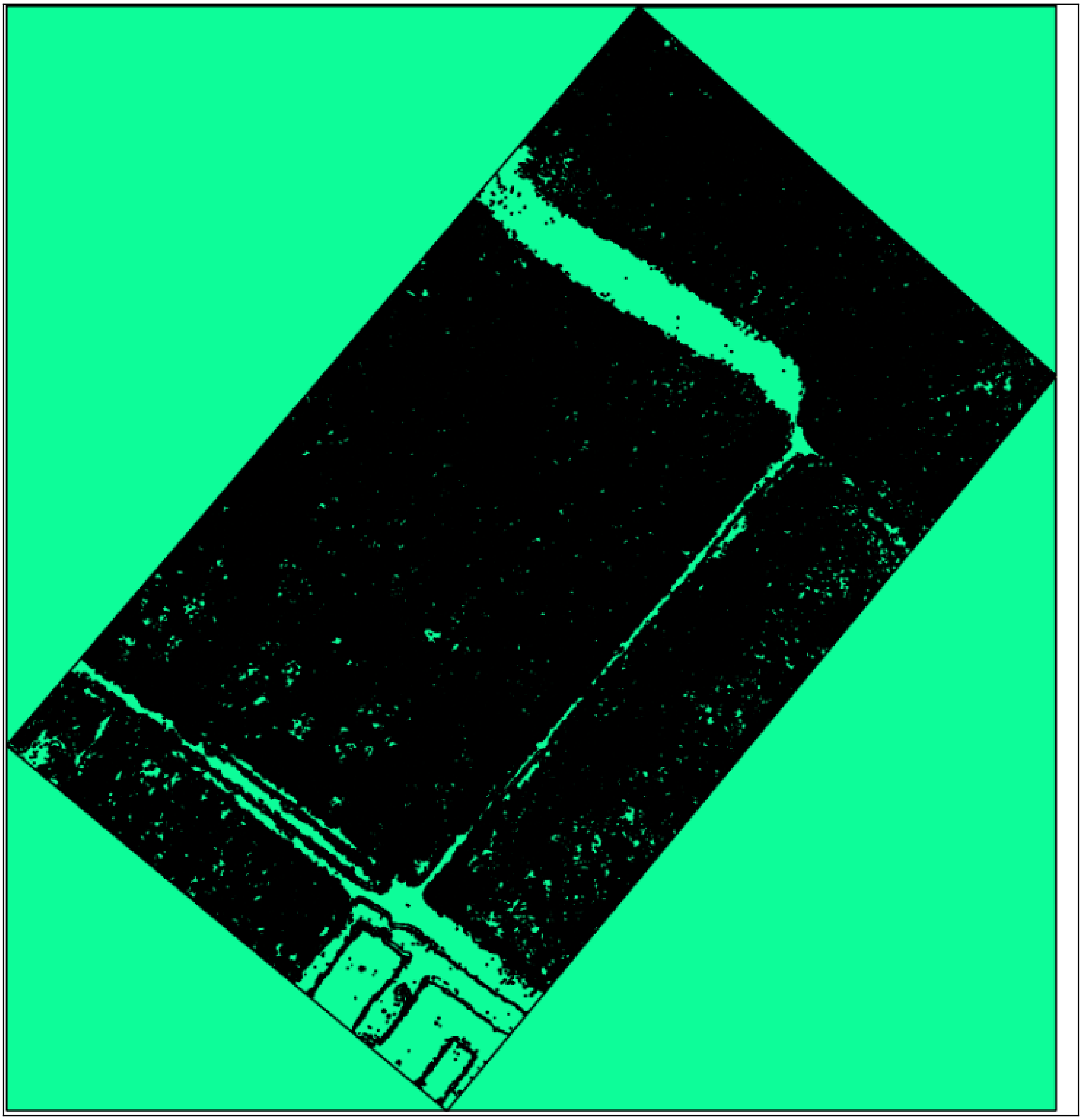

Segmentation

Step 68.

Repeat the segmentation process on the satellite image.

Object-based Manual Classification

Step 69.

Load the signature file “sigdroneall” on the “SCP: Classification” Panel and observe the signature plot. Use also the icon “identify features” and click on the segment to inquire the information of that particular certain segment.

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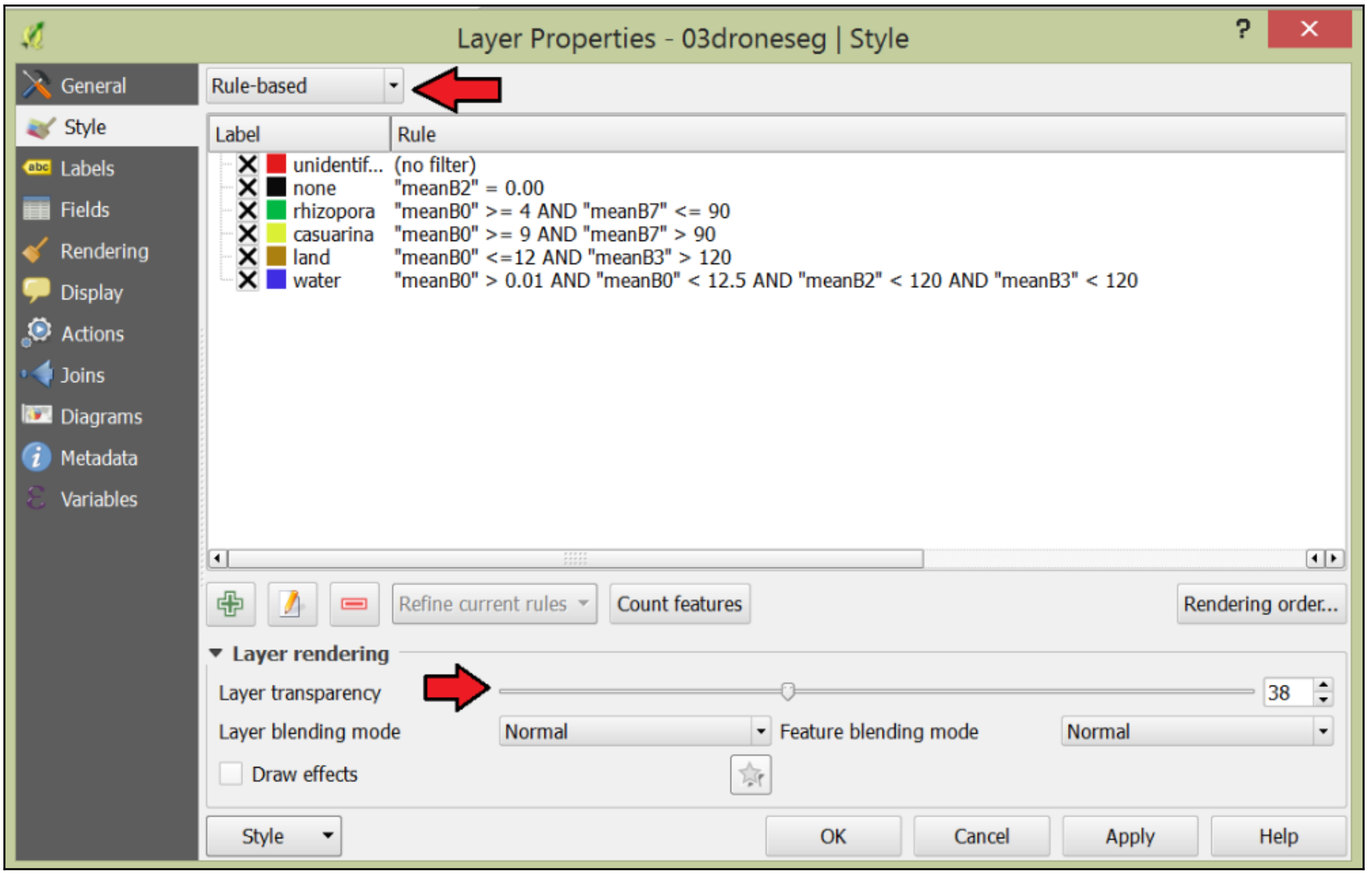
Step 70.

Open “droneseg03” properties. Click the tab Style and choose “Rule Based”. Start to write the rule from easiest feature to classify (e.g. water and land), until all designed features are covered. Increase the layer transparency. Click Apply to see the result. Add, refine and change the rule based on your visual judgment until a good classification is achieved.



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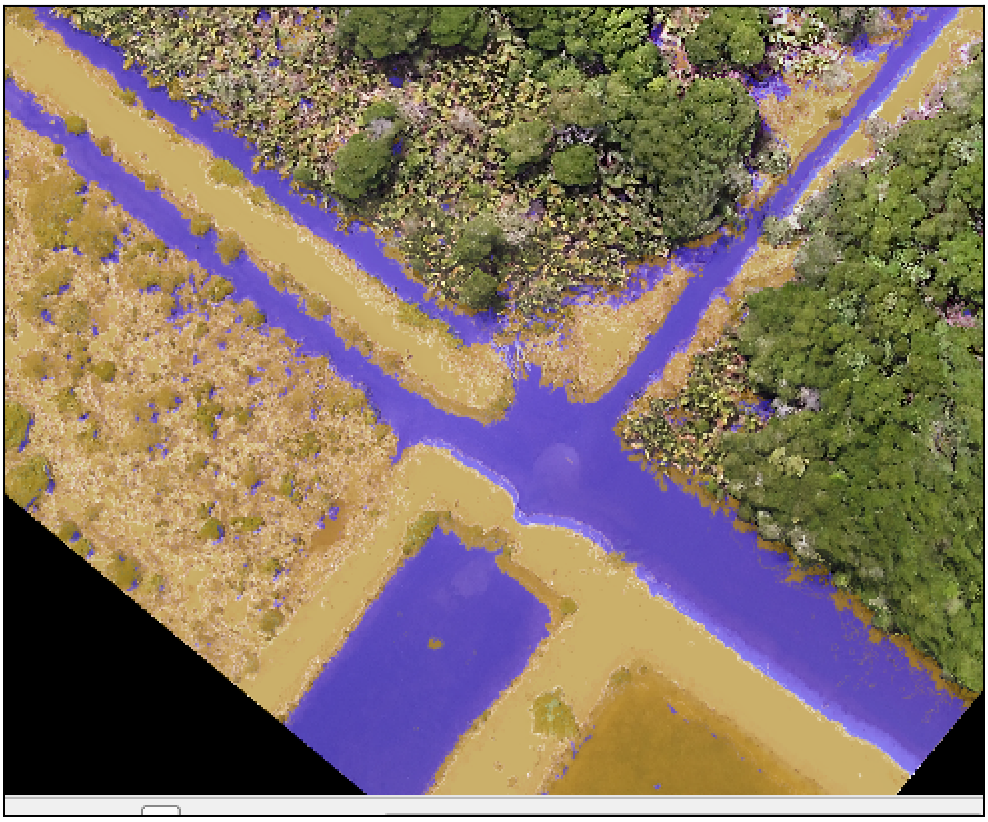

Object-based Manual Classification

Step 71.

After the rule is finished, click icon “Open Attribute Table” to open attribute table of the segments. On the opened window, click icon “Open Field Calculator” to open the Field Calculator

Attribute table - 03droneseg :: Features total: 267994, filtered: 267994, selected: 0

	label	nbPixels	meanB0	meanB1	meanB2	meanB3	meanB4	meanB5	meanB6	varB0	varB1	varB2	varB3	varB4
0	1	37072892	0.0000086...	0.0000371...	0.0000030...	0.0000339...	0.0001371...	0.0001236...	0.0001035...	0.0000693...	0.0013966...	0.0000163...	0.0010626...	0.0170051...
1	14	83	11.808319...	253.74699...	211.03614...	253.25300...	114.48192...	127.75903...	46.783130...	0.0034894...	9.0182924...	150.74389...	19.536584...	14.862804...
2	11	986	11.442484...	251.73326...	194.06085...	249.30831...	113.01825...	125.41987...	55.001014...	0.1047826...	20.454822...	350.19696...	55.589847...	298.26092...
3	53	140	11.066762...	249.77856...	165.35000...	243.75714...	95.742858...	109.09285...	42.607143...	0.3072167...	59.021583...	241.91366...	189.50718...	51.588130...
4	60	177	11.054908...	252.90960...	196.58192...	252.32203...	101.74011...	113.59322...	45.011299...	0.0442560...	3.1818182...	103.24716...	5.7329545...	183.54545...
5	94	59	9.8573532...	251.88136...	173.18644...	246.83050...	111.22033...	125.18643...	60.627117...	0.0122491...	10.172413...	111.22413...	58.831897...	411.14007...
6	206	62	10.641984...	251.98387...	182.33871...	248.90322...	67.354835...	78.161293...	24.935483...	0.0107581...	9.9836063...	408.39138...	97.860656...	134.19979...

Object-based Manual Classification

Step 72.

Put “classS” as Output field name. Choose “Text/String “as Output field type, and rewrite the rules from the previous step. As example:

CASE
WHEN "meanB1" <120 AND "meanB0" <12 THEN 'water'
WHEN "meanB1" > 120 AND "meanB0" < 12 THEN 'land'
WHEN "meanB0" >=12 AND "meanB0" <=18 THEN 'NF'
WHEN "meanB4" <160 AND "meanB0" > 18 THEN 'RA'
WHEN "meanB4" >=160 AND "meanB2" <160 AND "meanB0" >18 THEN 'deadtree'
WHEN "meanB4" >=160 AND "meanB0" > 18 THEN 'AA'
ELSE 'RA'

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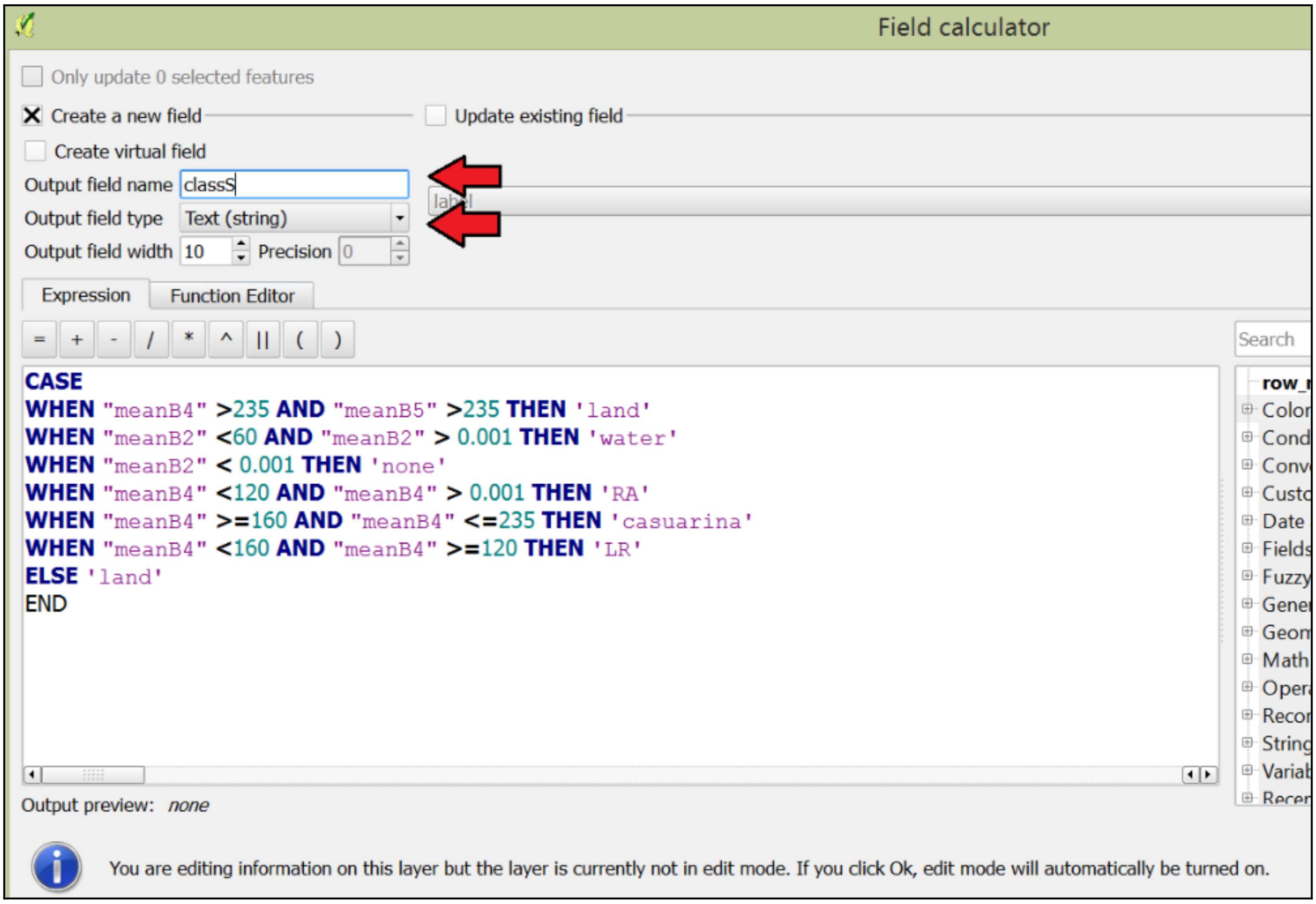
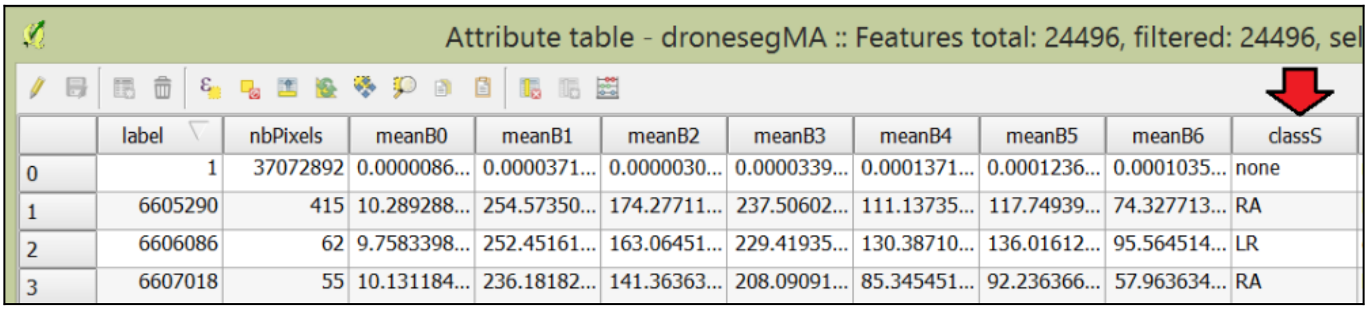
END



Object-based Manual Classification

Step 73.

Click OK. Wait until the process is finished. A new column “classS” will appear. Click icon to save the change. Now the segment is classified based on the rule.


Attribute table - dronesegMA :: Features total: 24496, filtered: 24496, sel

	label	nbPixels	meanB0	meanB1	meanB2	meanB3	meanB4	meanB5	meanB6	classS
0	1	37072892	0.0000086...	0.0000371...	0.0000030...	0.0000339...	0.0001371...	0.0001236...	0.0001035...	none
1	6605290	415	10.289288...	254.57350...	174.27711...	237.50602...	111.13735...	117.74939...	74.327713...	RA
2	6606086	62	9.7583398...	252.45161...	163.06451...	229.41935...	130.38710...	136.01612...	95.564514...	LR
3	6607018	55	10.131184...	236.18182...	141.36363...	208.09091...	85.345451...	92.236366...	57.963634...	RA

Object-based Manual Classification

Step 74.

Give the class integer code, using field calculator. This step is necessary because accuracy analysis only accept integer class label. Click icon to save the change. Now the segment is having integer label.

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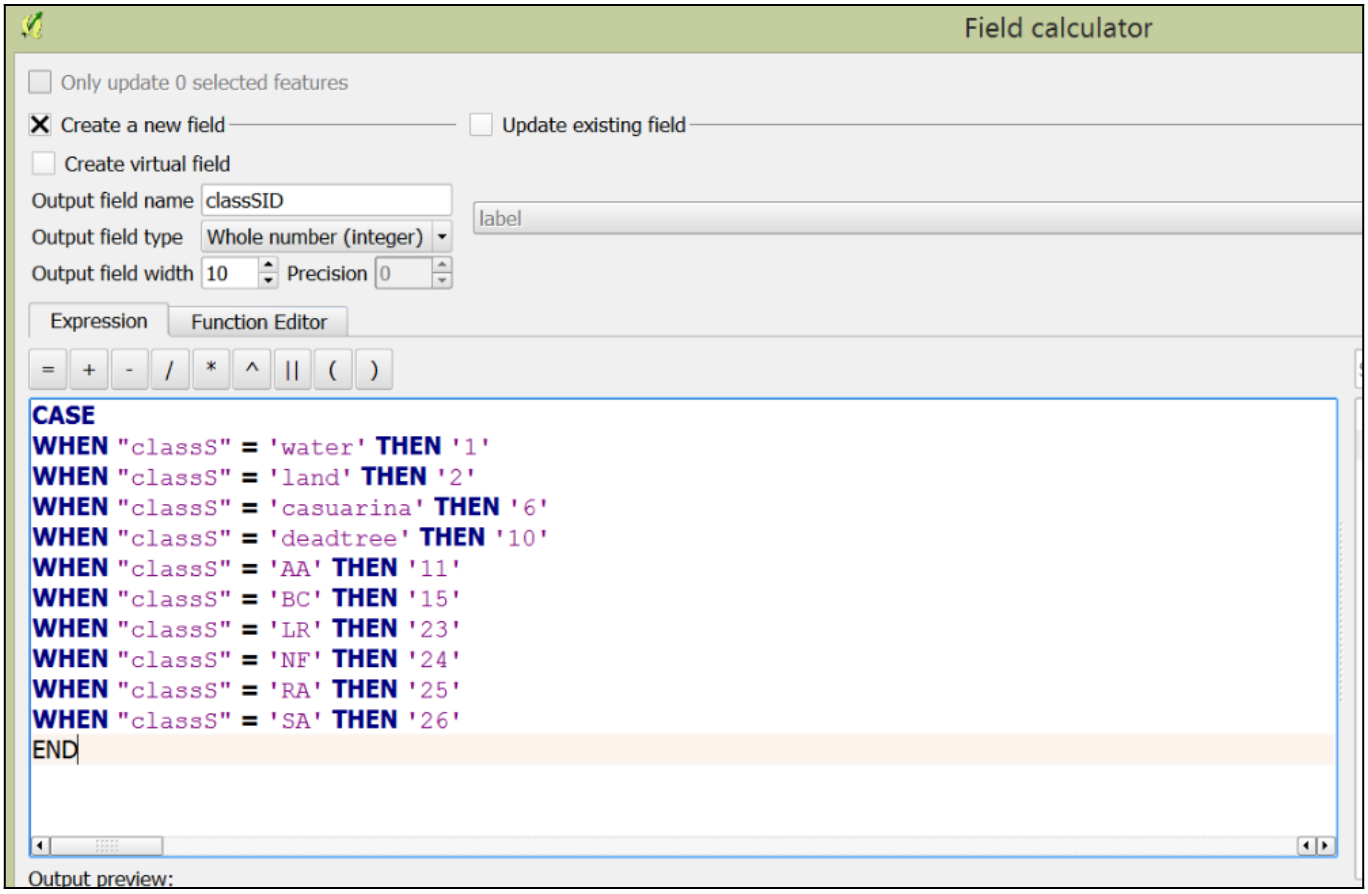
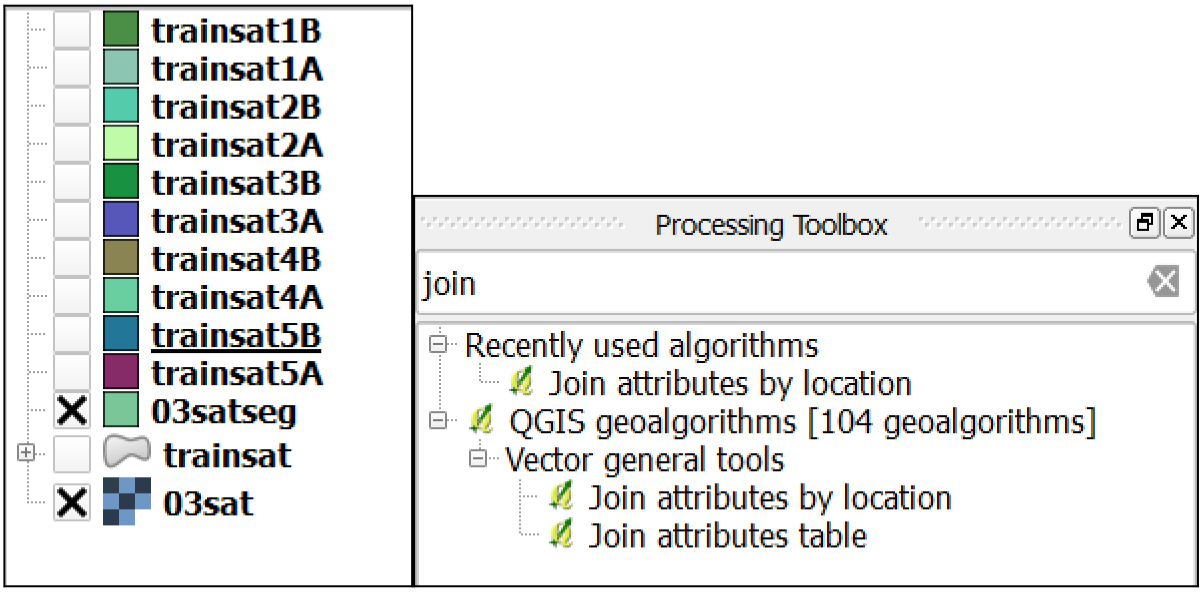


Object-based Automatic Classification

Step 75.

We use satellite image in batch process as example here.

Open all of the paired training files (trainsat1A-1B to trainsat5A-5B). Open also the segmentation result of satellite image (“03satseg”). On the “Processing Toolbox”, choose “Join attributes by location”



Object-based Automatic Classification

Step 76.

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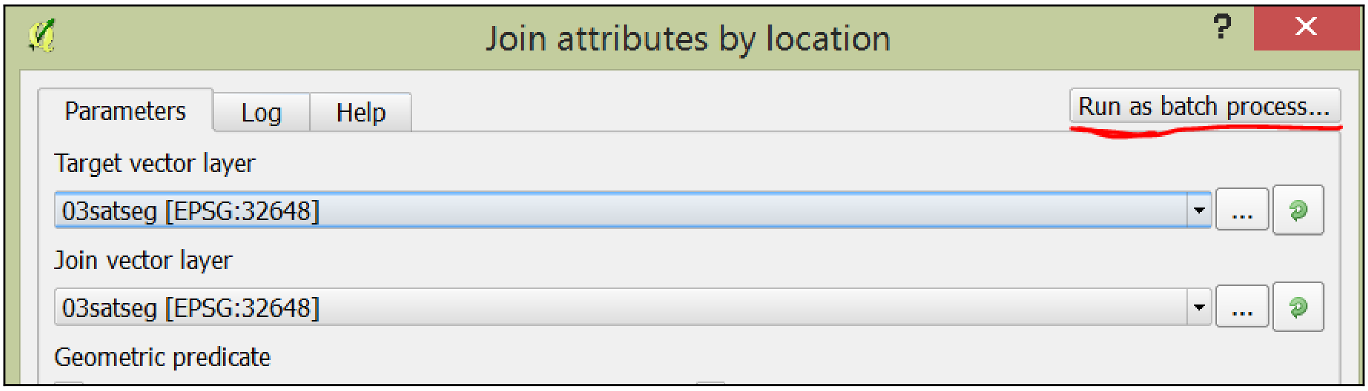
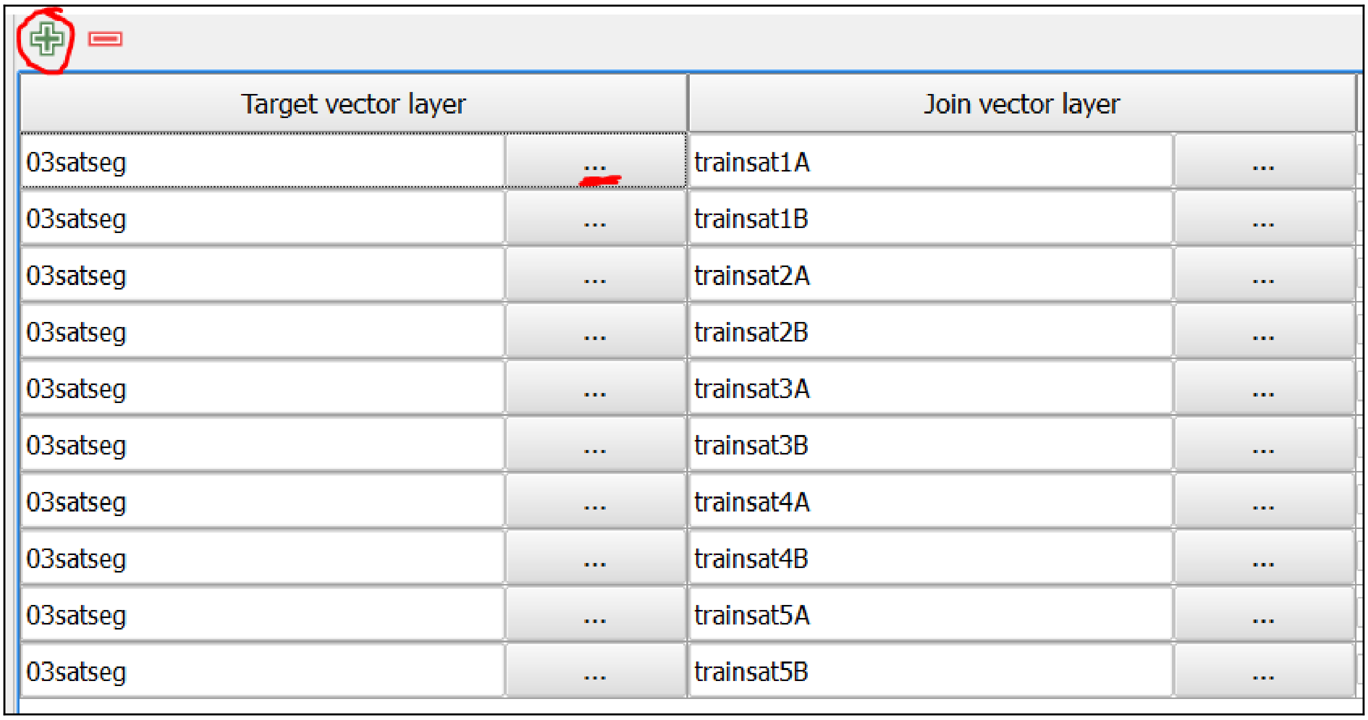
On the opened window, click “Run as batch process”. Click icon “add row / +” to add more rows. Open 10 rows in total.



Object-based Automatic Classification

Step 77.

Add “03satseg” as Target vector layer. Add paired training files (trainsat1A-1B to trainsat5A-5B) as Join vector layer.



Object-based Automatic Classification

Step 78.

Scroll right, tick “contains”, “equal”, “touches”, “overlaps”, and “within”.

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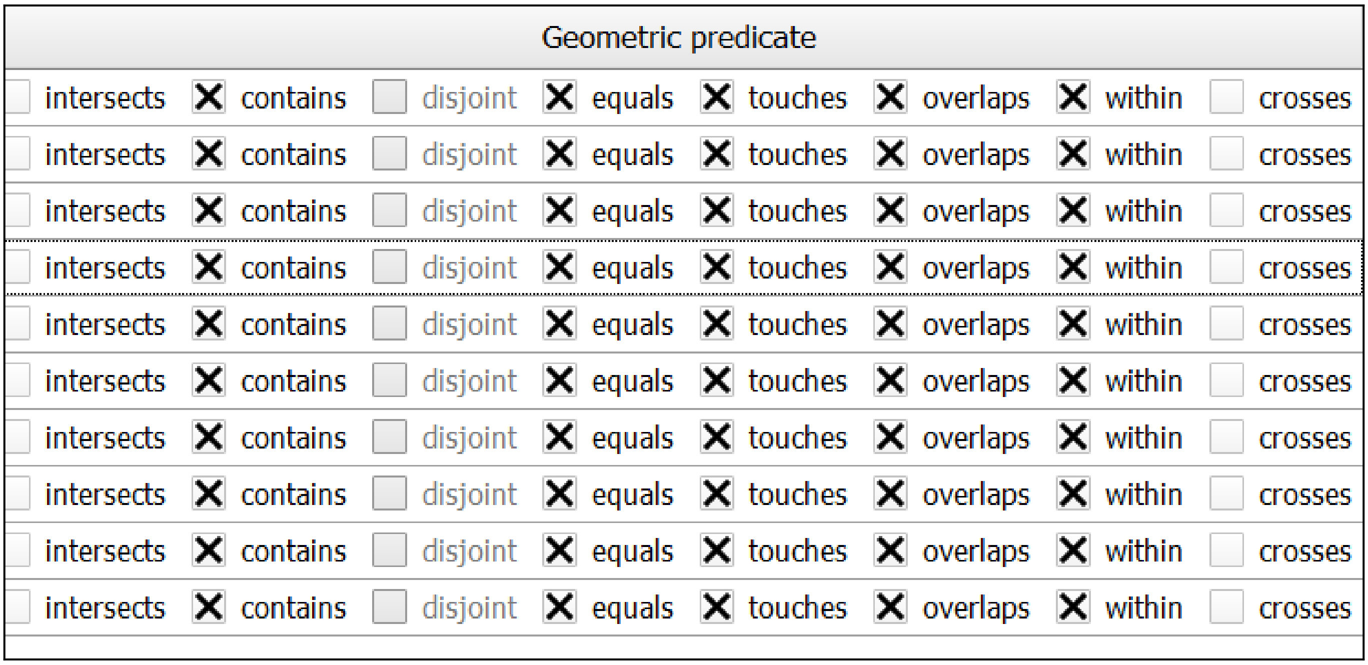
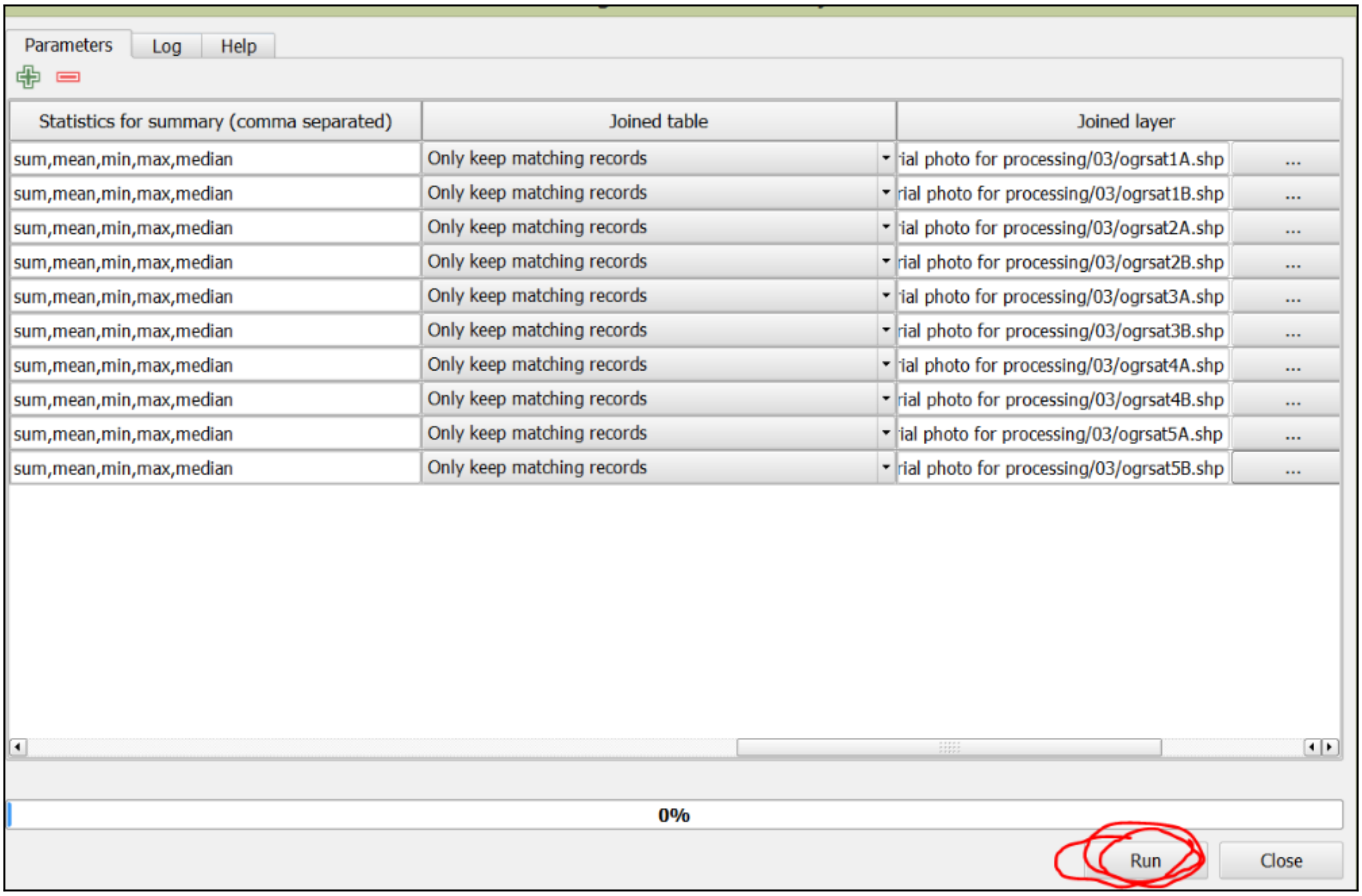


Geometric predicate							
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses
[ ] intersects	[X] contains	[ ] disjoint	[X] equals	[X] touches	[X] overlaps	[X] within	[ ] crosses

Object-based Automatic Classification

Step 79.

Scroll more to the right. In joined layer, give the file name “orgsat1A” to “orgsat5B”. Then click “Run”.



Statistics for summary (comma separated)	Joined table	Joined layer	
sum,mean,min,max,median	Only keep matching records	ial photo for processing/03/ogrsat1A.shp	...
sum,mean,min,max,median	Only keep matching records	rial photo for processing/03/ogrsat1B.shp	...
sum,mean,min,max,median	Only keep matching records	ial photo for processing/03/ogrsat2A.shp	...
sum,mean,min,max,median	Only keep matching records	rial photo for processing/03/ogrsat2B.shp	...
sum,mean,min,max,median	Only keep matching records	ial photo for processing/03/ogrsat3A.shp	...
sum,mean,min,max,median	Only keep matching records	rial photo for processing/03/ogrsat3B.shp	...
sum,mean,min,max,median	Only keep matching records	ial photo for processing/03/ogrsat4A.shp	...
sum,mean,min,max,median	Only keep matching records	rial photo for processing/03/ogrsat4B.shp	...
sum,mean,min,max,median	Only keep matching records	ial photo for processing/03/ogrsat5A.shp	...
sum,mean,min,max,median	Only keep matching records	rial photo for processing/03/ogrsat5B.shp	...

Object-based Automatic Classification

Step 80.

Remove the joined layer. Open the vector file “orgsat1A” to “orgsat5B” and click icon Table Manager . If

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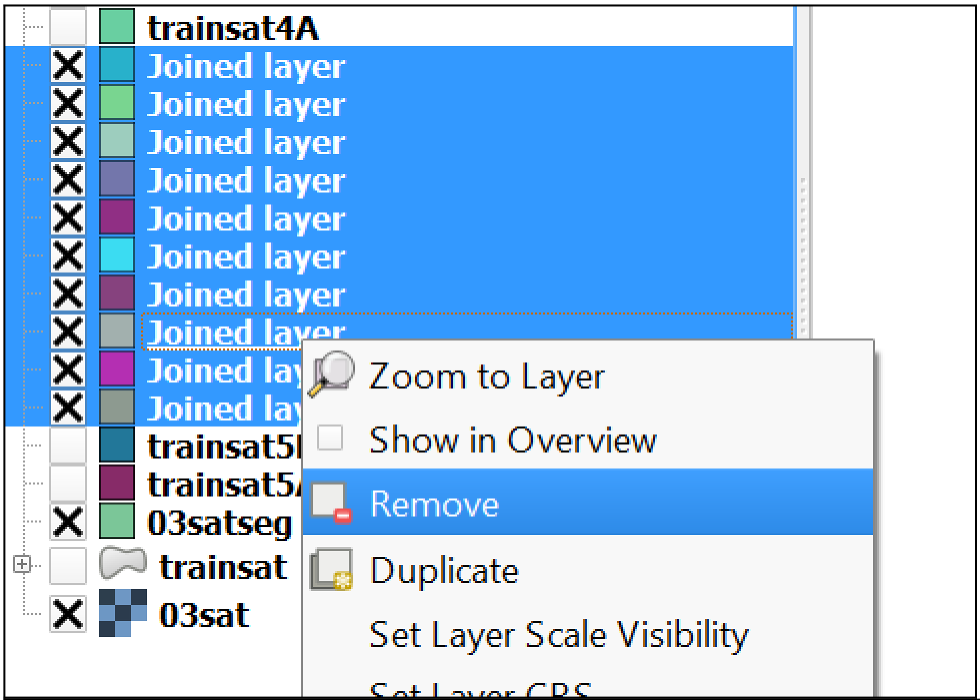
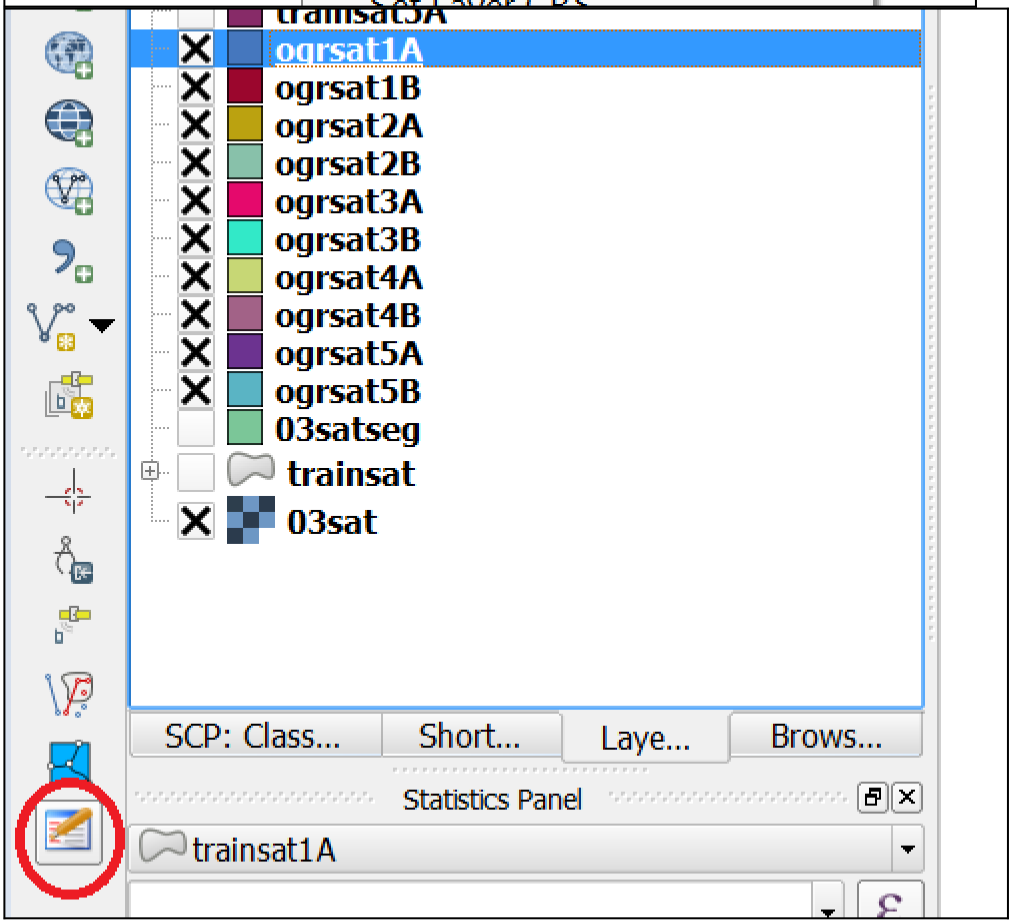
you do not have table manager, install this plugin.





Object-based Automatic Classification

Step 81.

On the opened window, delete the fields “MC_ID”, “MC_info” and “C_info”. Change the “classID” to “class”. Click “Save”.

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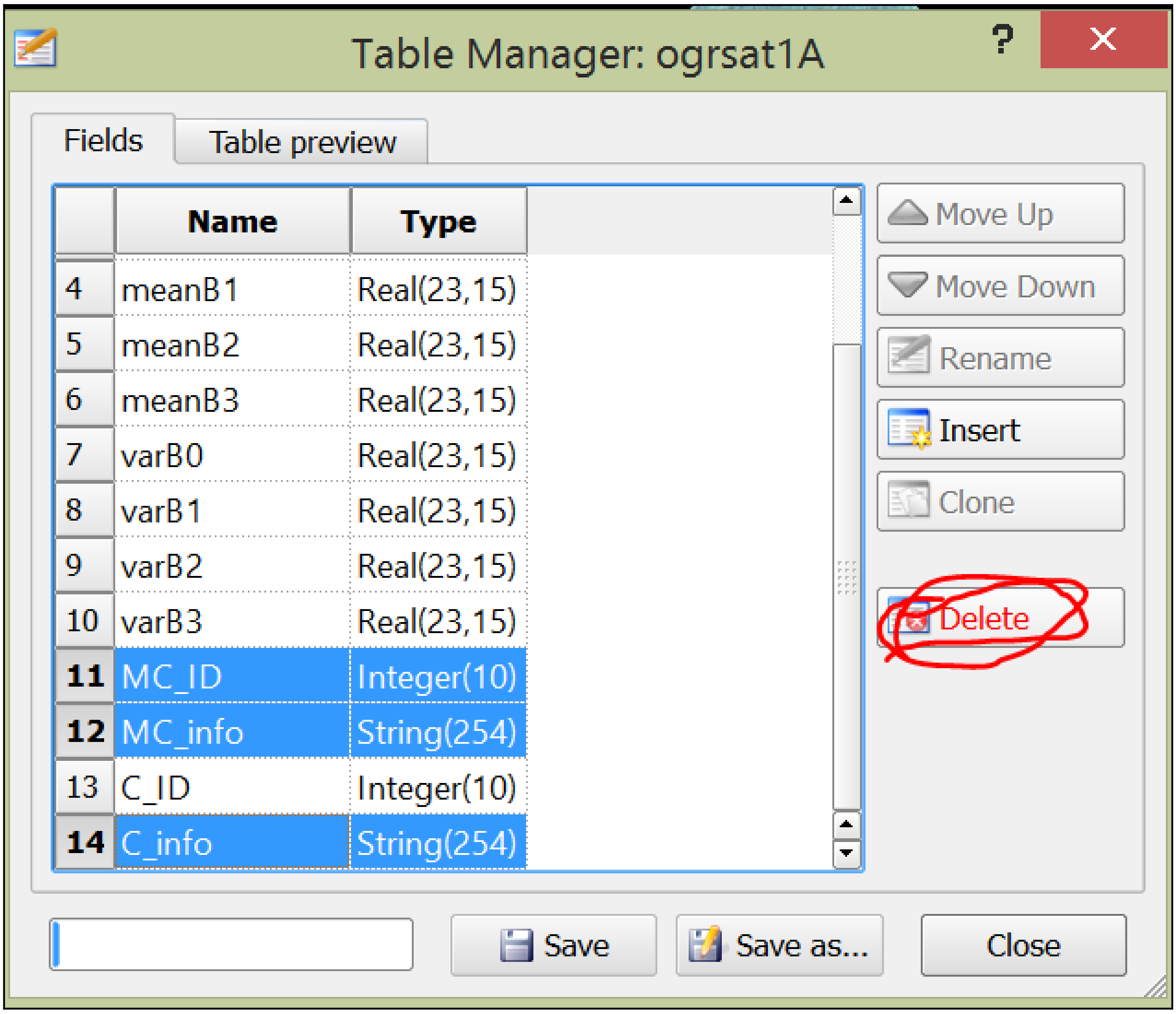

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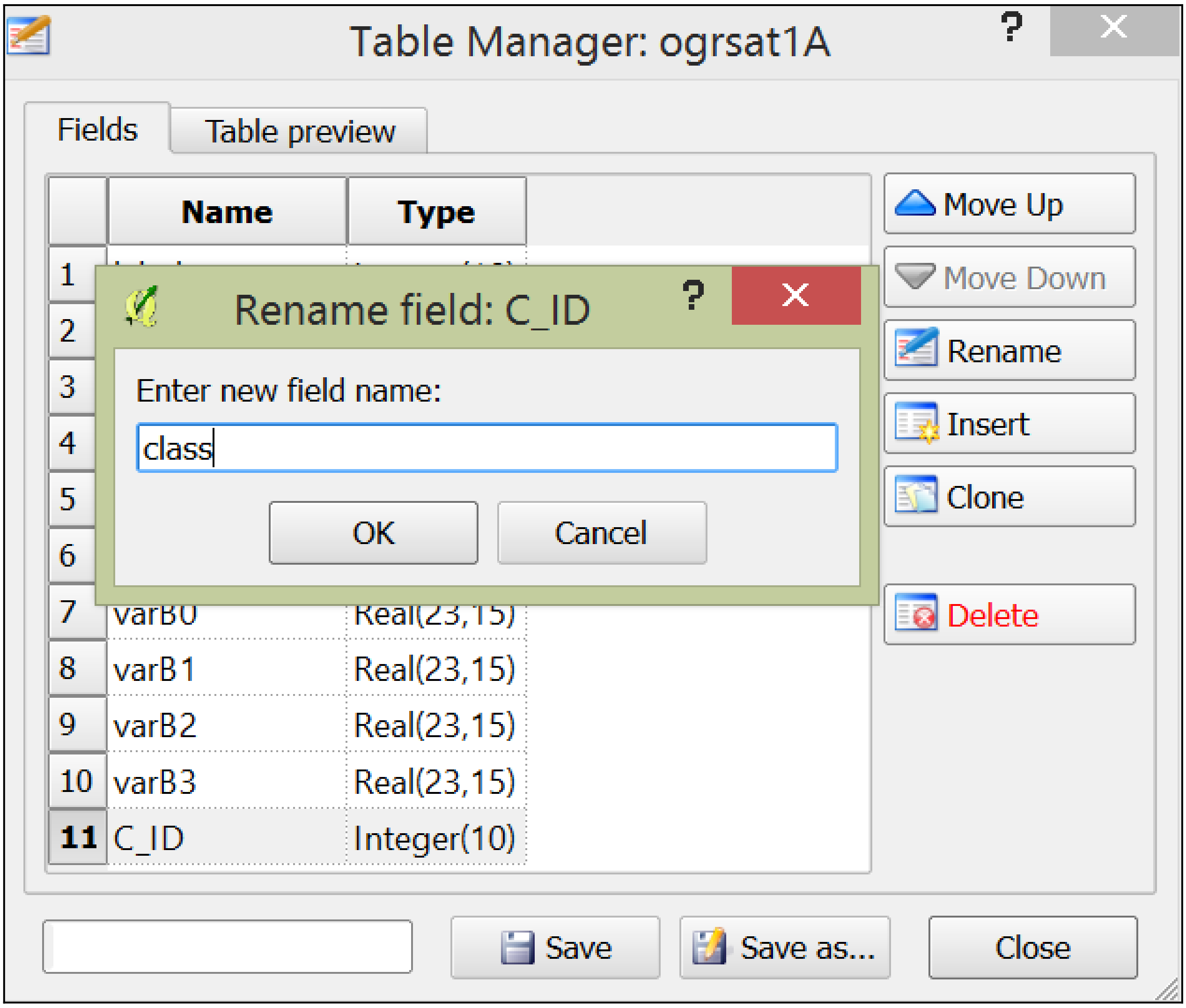

Object-based Automatic Classification

Step 82.

Minimize the QGIS. Open software called OSGeo4WShell, which is installed together with QGIS.

Object-based Automatic Classification

Step 83.

Type otbgui_ComputeOGRLayersFeaturesStatistics and press enter.

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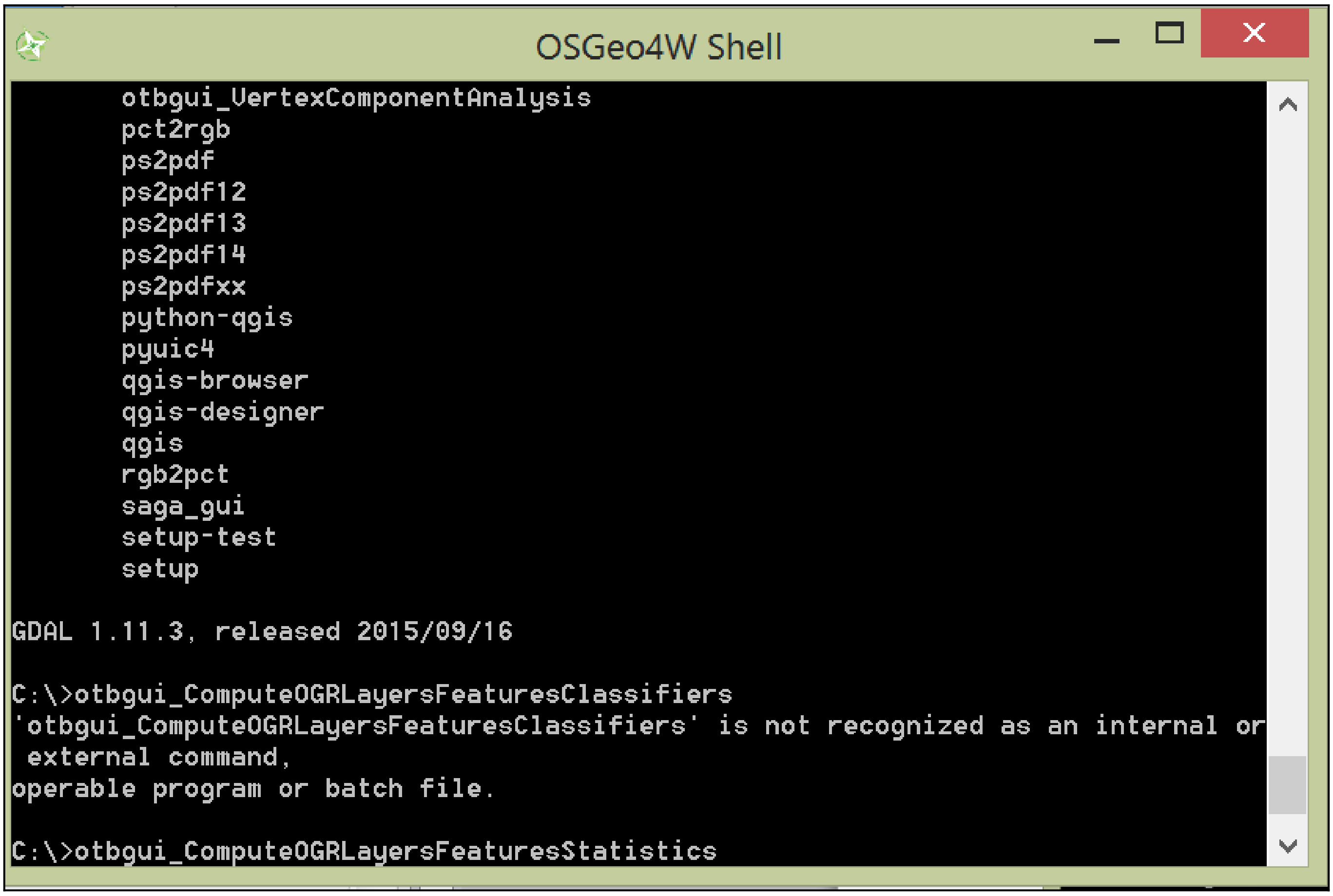

Object-based Automatic Classification

Step 84.

On the opened window, put the “03satseg.shp” as input shapefile, and create “03satseg.xml” as XML file containing mean and variance of each feature. Click “meanB0” to “meanB6” as features to consider. Click “Execute”.

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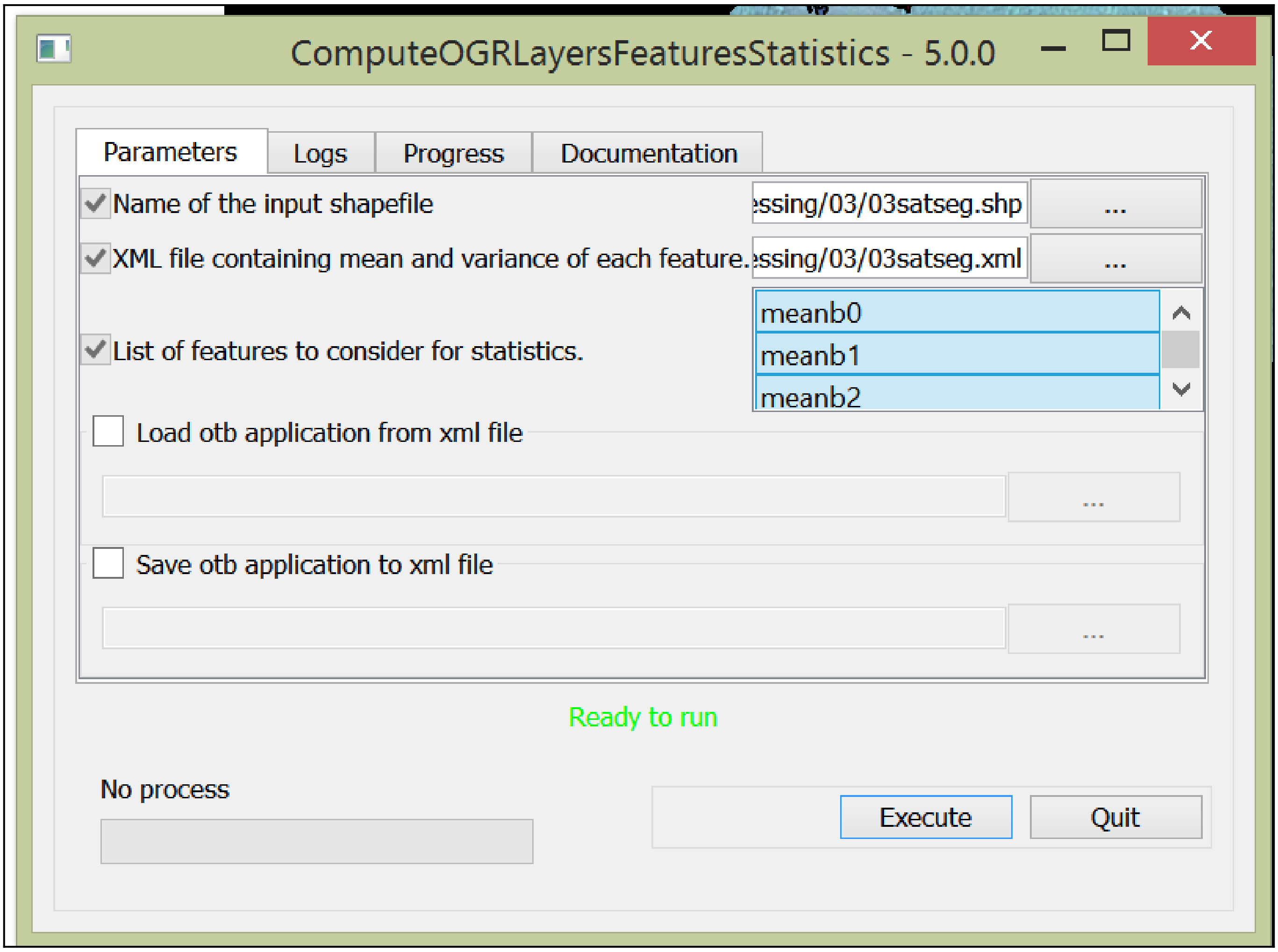

Object-based Automatic Classification

Step 85.

Put the “orgsat1A.shp” as input shapefile, and create “orgsat1A.xml” as XML file containing mean and variance of each feature. Click “meanB0” to “meanB6” as feature to consider. Click Execute. Repeat this process to “orgsat1B” and so on. Close the ComputeOGR window.

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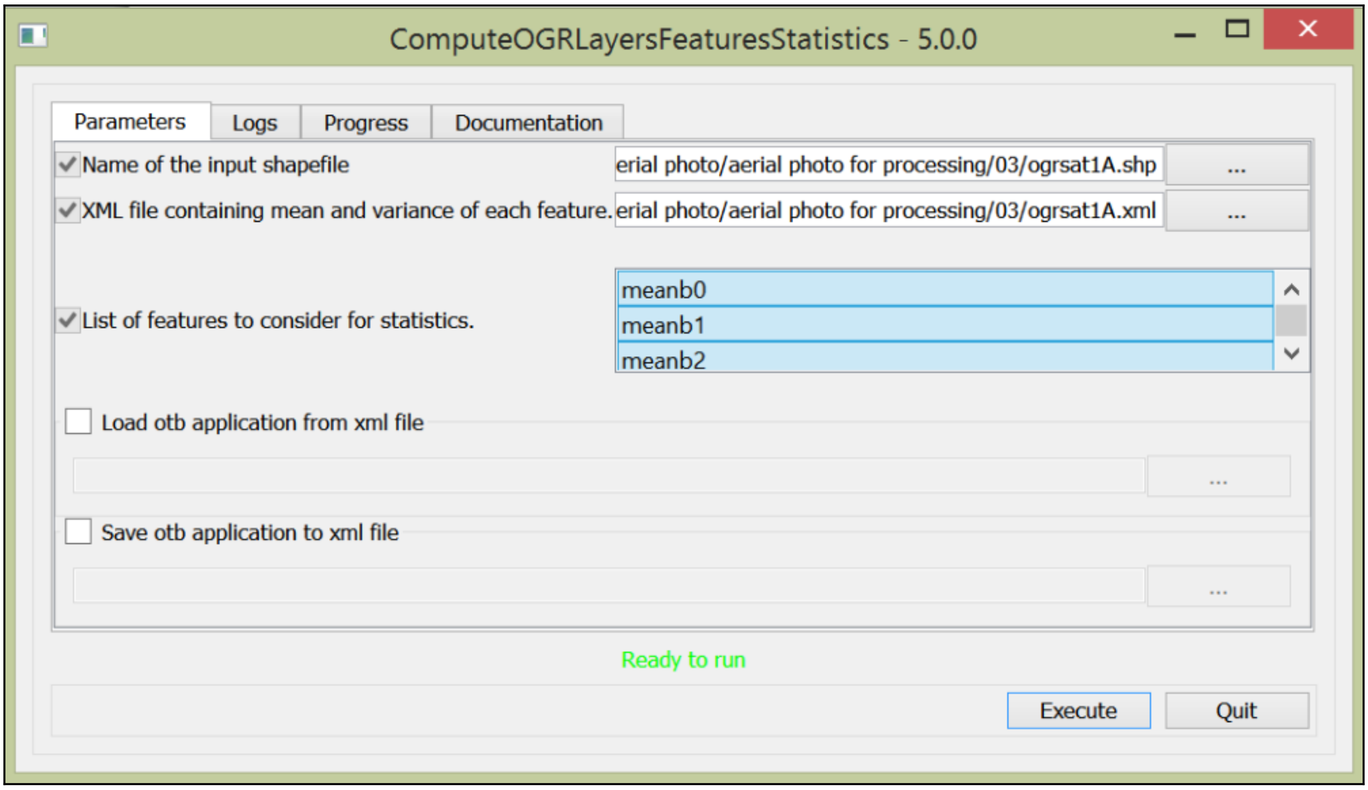
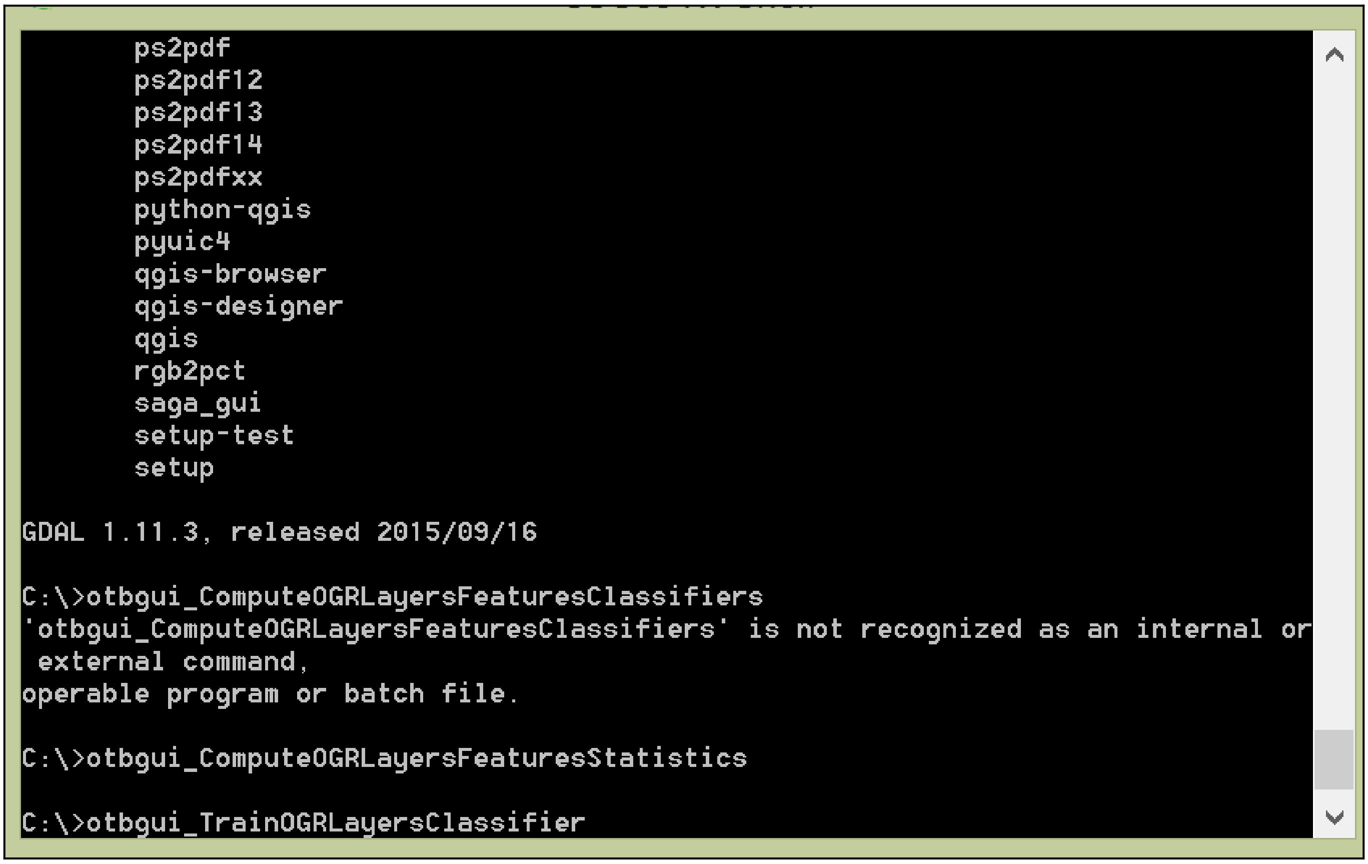


Object-based Automatic Classification

Step 86.

Type otbgui_TrainOGRLayersClassifier and press enter



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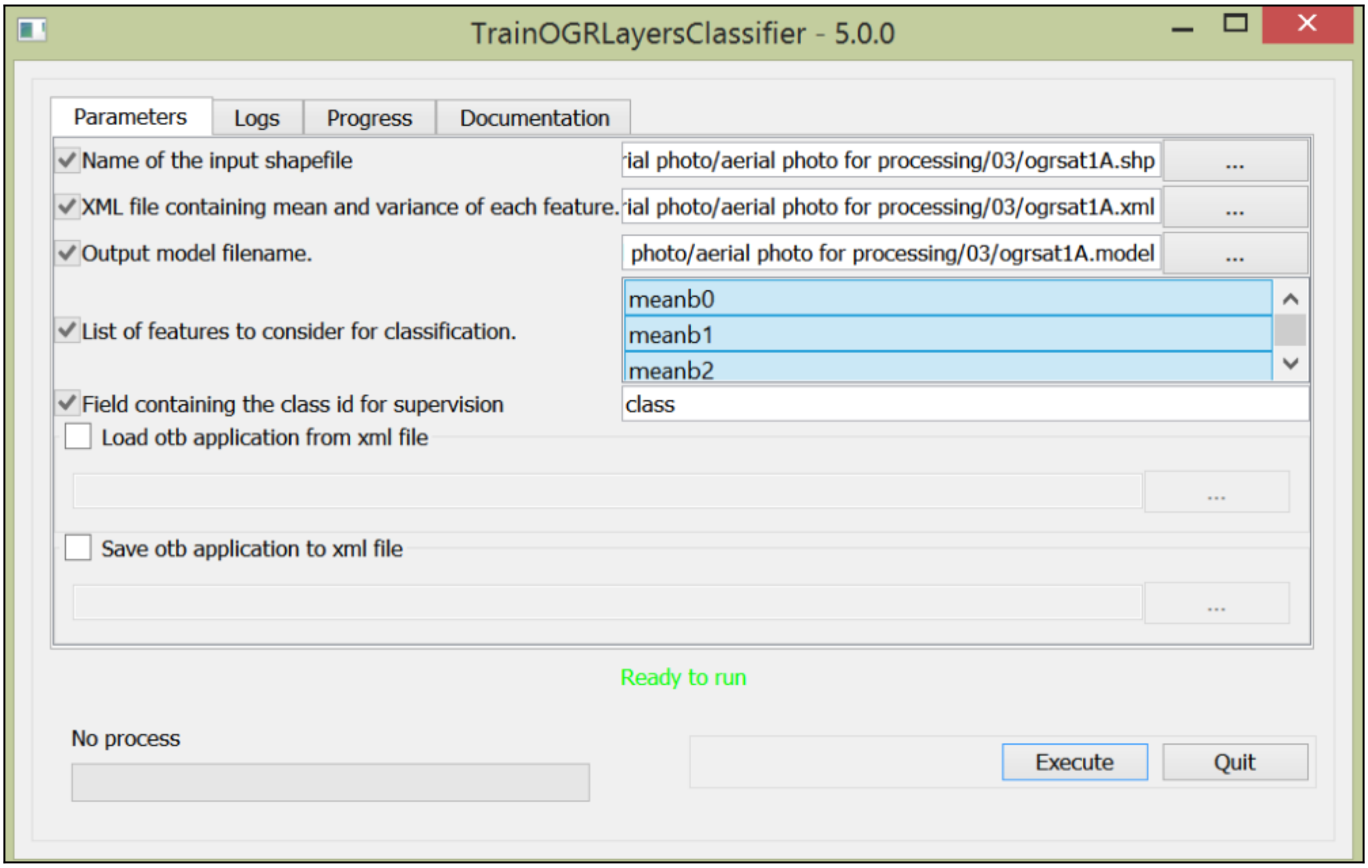
Object-based Automatic Classification

Step 87.

Put the “orgsat1A.shp” as input shapefile, and put “orgsat1A.xml” as XML file containing mean and variance of each feature. Create Output model filename and name it “orgsat1A.model”. Click “meanB0” to “meanB6” as features to consider. Click “Execute”. Repeat this process to orgsat1B and so on. Close the TrainOGR window.



Object-based Automatic Classification

Step 88.

Type otbgui_OGRLayeClassifier and press enter.

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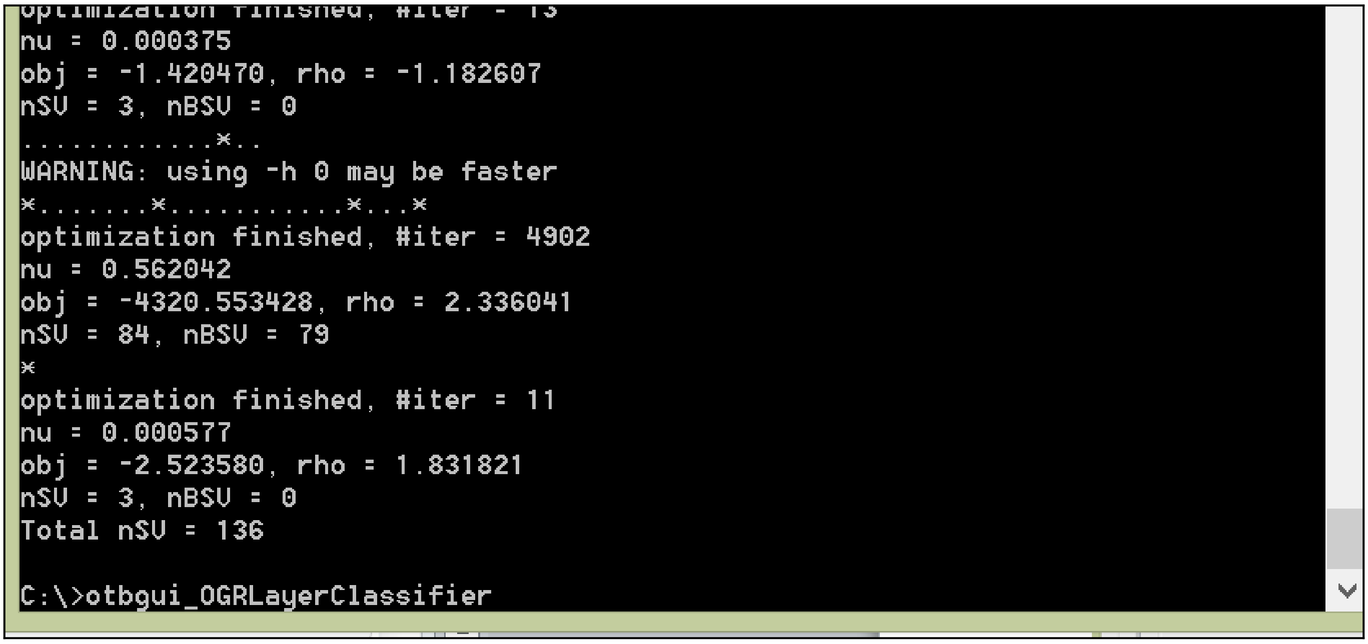

Object-based Automatic Classification

Step 89.

Put the “03satseg” as input shapefile, and put “03satseg.xml” as XML file containing mean and variance of each feature. Put “orgsat1A.model” as input model filename. Click “meanB0” to “meanB6” as features to consider. Type “class1A” on the “Field containing predicted class”. Click “Execute”. Repeat this process, using “orgsat1B.model” to create “class1B” and so on. Close the window and close OSGeo4WShell

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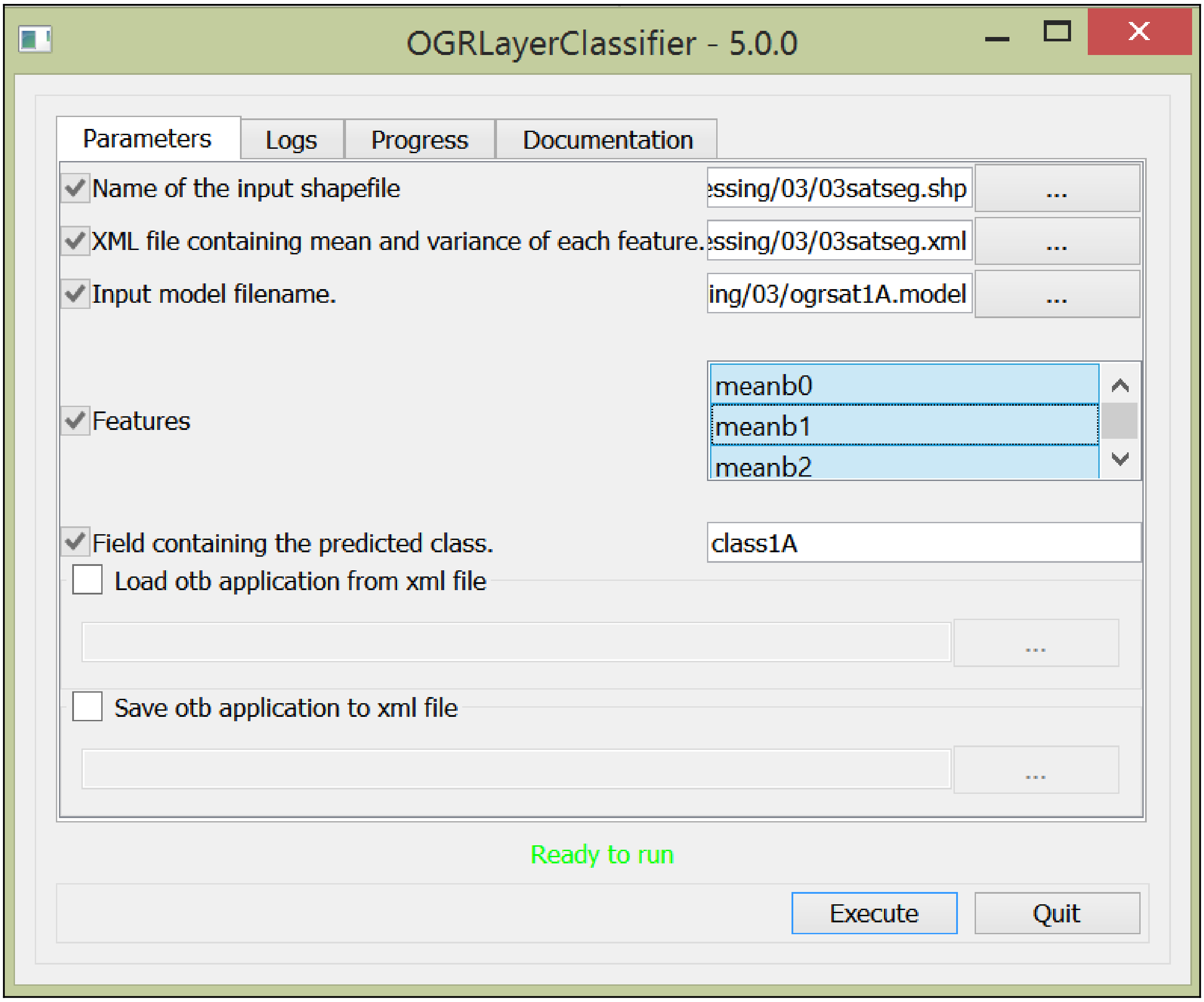

Object-based Automatic Classification

Step 90.

On QGIS, close and load 03satseg.shp. Click icon to open attribute file. Now the shapefile is containing class1A – class5B, which contain classification for each segments

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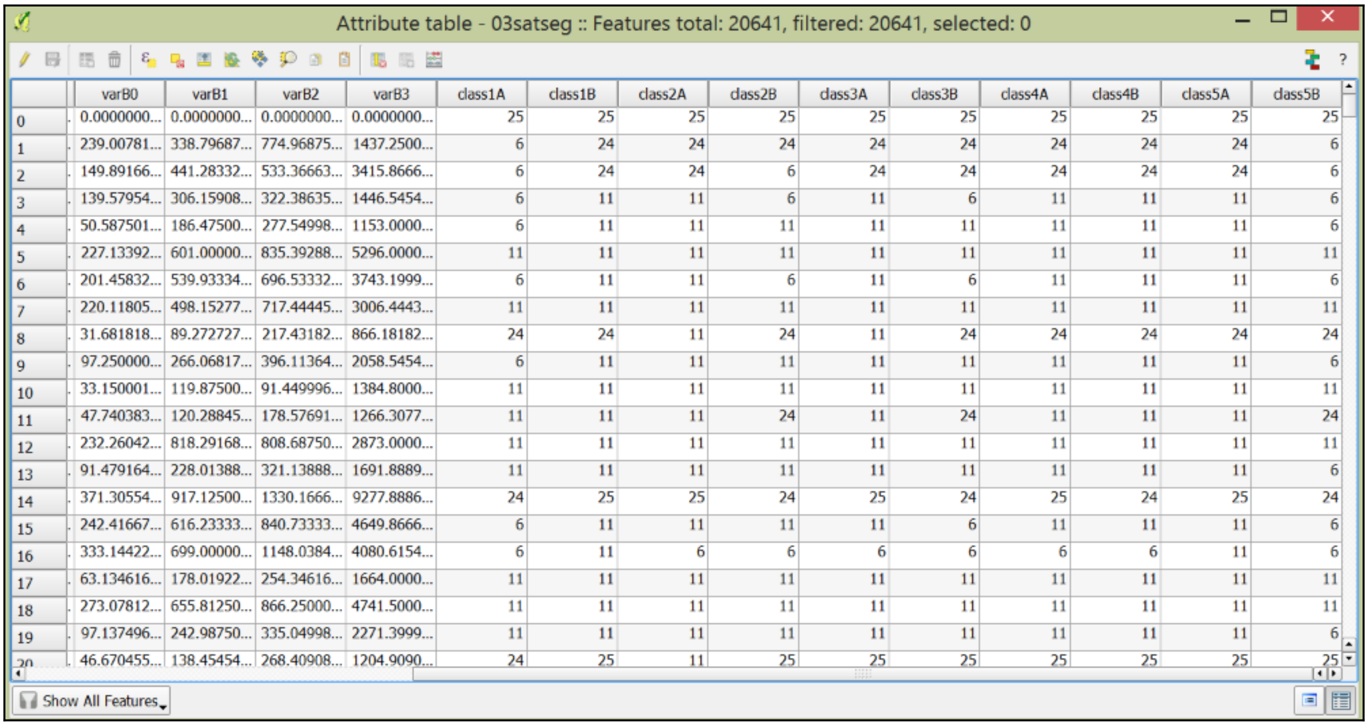

Attribute table - 03satseg :: Features total: 20641, filtered: 20641, selected: 0

	varB0	varB1	varB2	varB3	class1A	class1B	class2A	class2B	class3A	class3B	class4A	class4B	class5A	class5B
0	0.0000000...	0.0000000...	0.0000000...	0.0000000...	25	25	25	25	25	25	25	25	25	25
1	239.00781...	338.79687...	774.96875...	1437.2500...	6	24	24	24	24	24	24	24	24	6
2	149.89166...	441.28332...	533.36663...	3415.8666...	6	24	24	6	24	24	24	24	24	6
3	139.57954...	306.15908...	322.38635...	1446.5454...	6	11	11	6	11	6	11	11	11	6
4	50.587501...	186.47500...	277.54998...	1153.0000...	6	11	11	11	11	11	11	11	11	6
5	227.13392...	601.00000...	835.39288...	5296.0000...	11	11	11	11	11	11	11	11	11	11
6	201.45832...	539.93334...	696.53332...	3743.1999...	6	11	11	6	11	6	11	11	11	6
7	220.11805...	498.15277...	717.44445...	3006.4443...	11	11	11	11	11	11	11	11	11	11
8	31.681818...	89.272727...	217.43182...	866.18182...	24	24	11	24	11	24	24	24	24	24
9	97.250000...	266.06817...	396.11364...	2058.5454...	6	11	11	11	11	11	11	11	11	6
10	33.150001...	119.87500...	91.449996...	1384.8000...	11	11	11	11	11	11	11	11	11	11
11	47.740383...	120.28845...	178.57691...	1266.3077...	11	11	11	24	11	24	11	11	11	24
12	232.26042...	818.29168...	808.68750...	2873.0000...	11	11	11	11	11	11	11	11	11	11
13	91.479164...	228.01388...	321.13888...	1691.8889...	11	11	11	11	11	11	11	11	11	6
14	371.30554...	917.12500...	1330.1666...	9277.8886...	24	25	25	24	25	24	25	24	25	24
15	242.41667...	616.23333...	840.73333...	4649.8666...	6	11	11	11	11	6	11	11	11	6
16	333.14422...	699.00000...	1148.0384...	4080.6154...	6	11	6	6	6	6	6	6	11	6
17	63.134616...	178.01922...	254.34616...	1664.0000...	11	11	11	11	11	11	11	11	11	11
18	273.07812...	655.81250...	866.25000...	4741.5000...	11	11	11	11	11	11	11	11	11	11
19	97.137496...	242.98750...	335.04998...	2271.3999...	11	11	11	11	11	11	11	11	11	6
20	46.670455...	138.45454...	268.40908...	1204.9090...	24	25	11	25	25	25	25	25	25	25

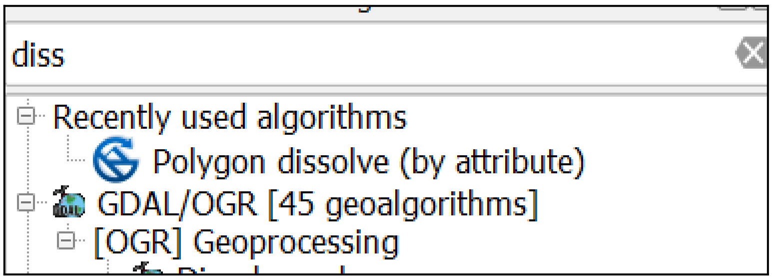
Show All Features

Merging Classified Vector and Convert to Raster

Step 91.

In this example we merge the class in batch process.

On the “Processing Toolbox” panel, open Polygon dissolve (by attribute), then click “Batch Process"



Merging Classified Vector and Convert to Raster

Step 92.

Add more rows (we need 10 rows). Put “03satseg” as Polygons, and put “class1A to “class5B” as attribute. Choose “No” for Keep inner boundaries.

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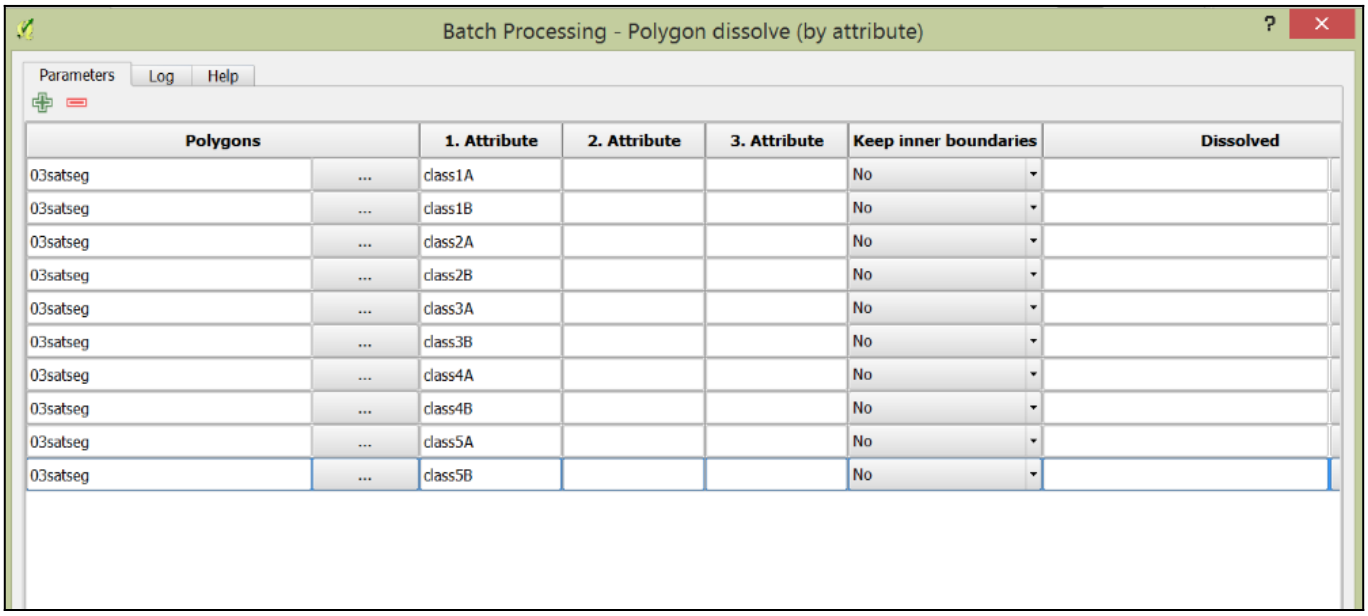
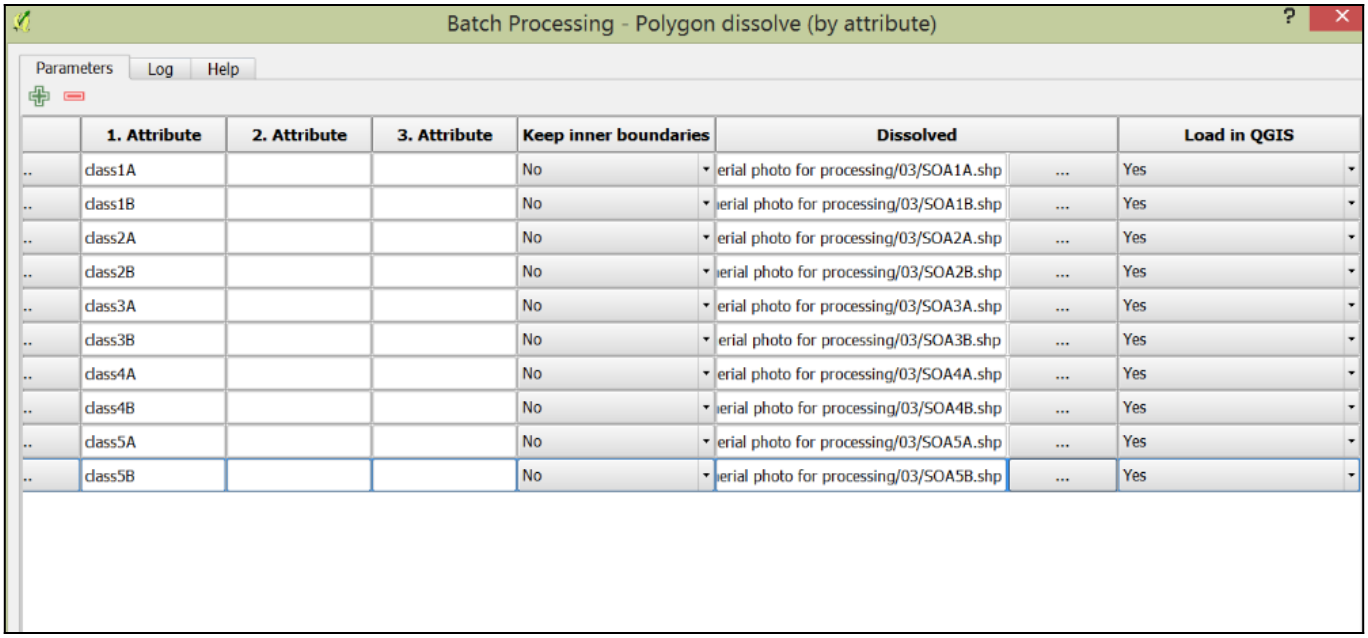


Polygons		1. Attribute	2. Attribute	3. Attribute	Keep inner boundaries	Dissolved
03satseg	...	class1A			No	
03satseg	...	class1B			No	
03satseg	...	class2A			No	
03satseg	...	class2B			No	
03satseg	...	class3A			No	
03satseg	...	class3B			No	
03satseg	...	class4A			No	
03satseg	...	class4B			No	
03satseg	...	class5A			No	
03satseg	...	class5B			No	

Merging Classified Vector and Convert to Raster

Step 93.

Give the name of dissolved file “SOA1A” to “SOA5B”– for Satellite Object-based Automatic classification. Click Run.



	1. Attribute	2. Attribute	3. Attribute	Keep inner boundaries	Dissolved		Load in QGIS
..	class1A			No	erial photo for processing/03/SOA1A.shp	...	Yes
..	class1B			No	erial photo for processing/03/SOA1B.shp	...	Yes
..	class2A			No	erial photo for processing/03/SOA2A.shp	...	Yes
..	class2B			No	erial photo for processing/03/SOA2B.shp	...	Yes
..	class3A			No	erial photo for processing/03/SOA3A.shp	...	Yes
..	class3B			No	erial photo for processing/03/SOA3B.shp	...	Yes
..	class4A			No	erial photo for processing/03/SOA4A.shp	...	Yes
..	class4B			No	erial photo for processing/03/SOA4B.shp	...	Yes
..	class5A			No	erial photo for processing/03/SOA5A.shp	...	Yes
..	class5B			No	erial photo for processing/03/SOA5B.shp	...	Yes

Merging Classified Vector and Convert to Raster

Step 94.

Open the vector files “SOA1A” to “SOA5B”. On the “Processing Toolbox” panel, click “Rasterize (vector to raster)”

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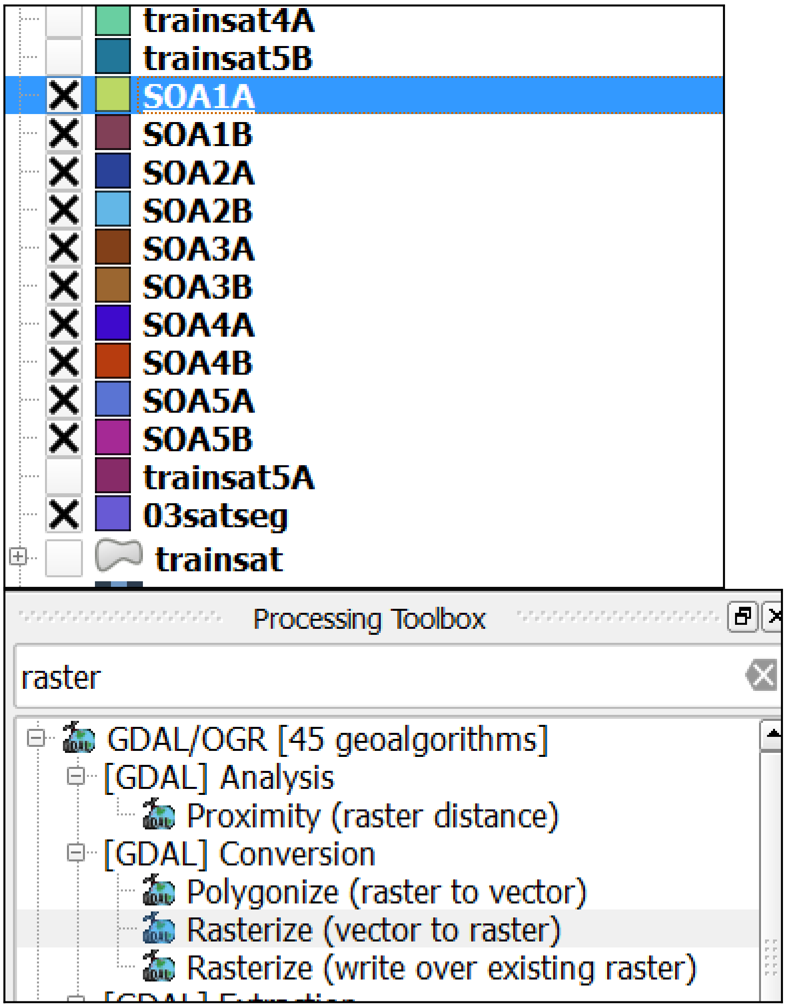
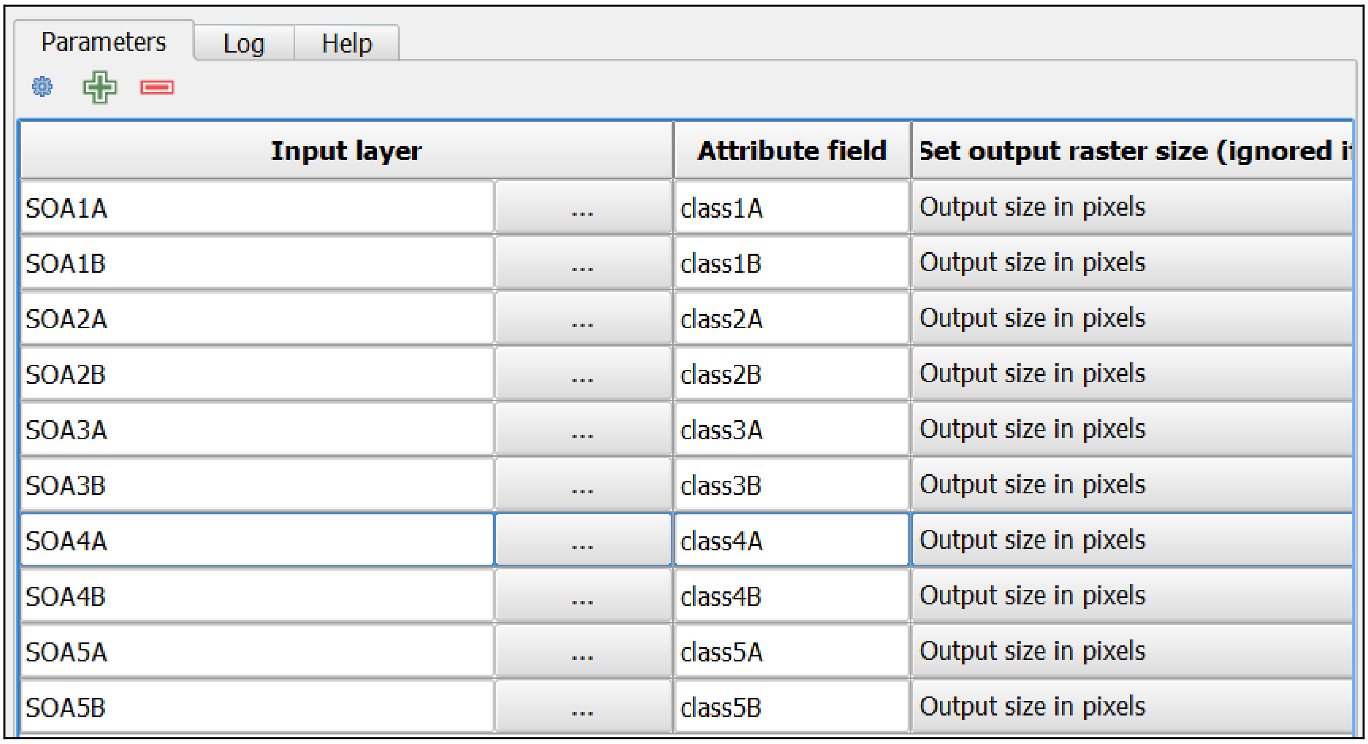


Merging Classified Vector and Convert to Raster

Step 95.

Click Batch Process. Put “SOA1A” to “SOA5B” as input layer, and “class1A” to “class 5B” as attribute field.



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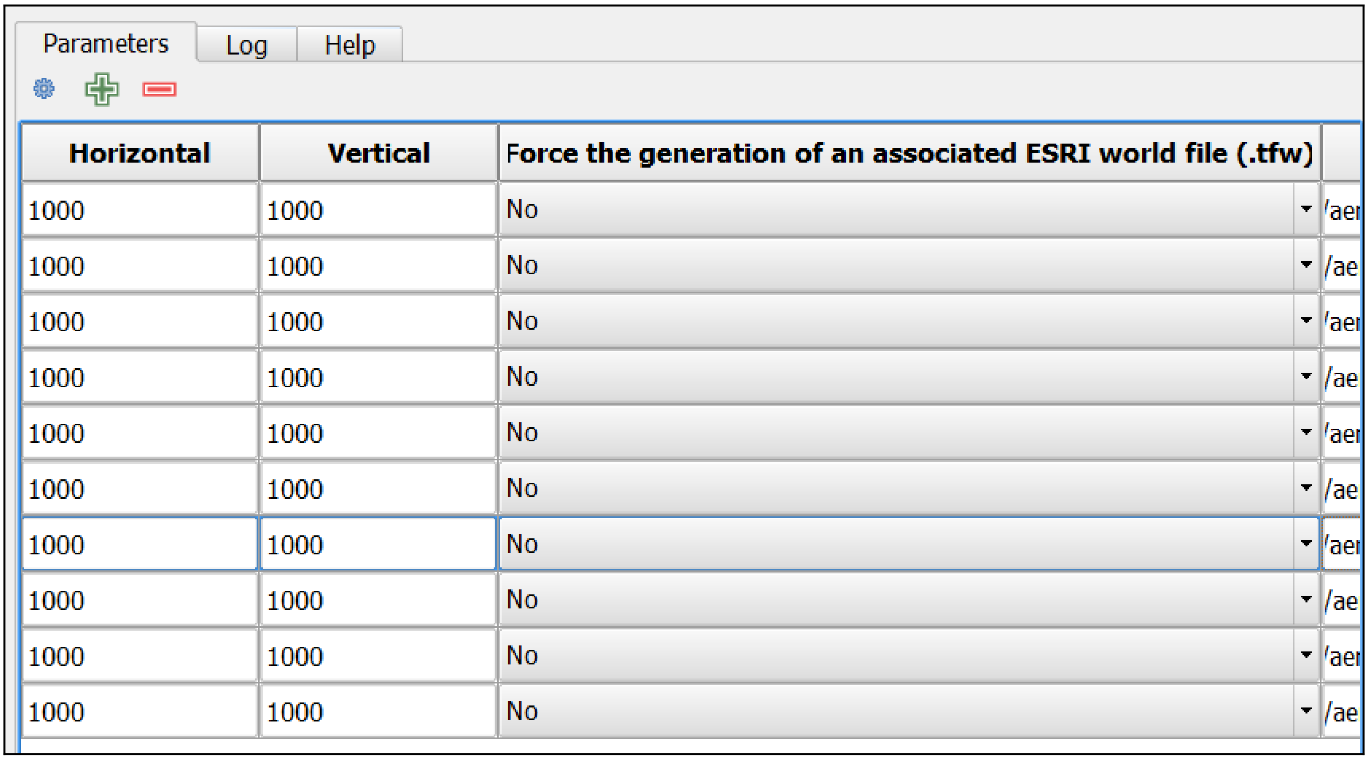
Merging Classified Vector and Convert to Raster

Step 96.

Scroll to the right. Put 1000 for Horizontal and Vertical value (for drone put 3000).



Horizontal	Vertical	Force the generation of an associated ESRI world file (.tfw)	
1000	1000	No	/aer
1000	1000	No	/ae
1000	1000	No	/aer
1000	1000	No	/ae
1000	1000	No	/aer
1000	1000	No	/ae
1000	1000	No	/aer
1000	1000	No	/ae
1000	1000	No	/aer
1000	1000	No	/ae

Merging Classified Vector and Convert to Raster

Step 97.

Scroll to the right. Give name to the raster .tif file “SOA1A” to “SOA5B”. Click “Run”

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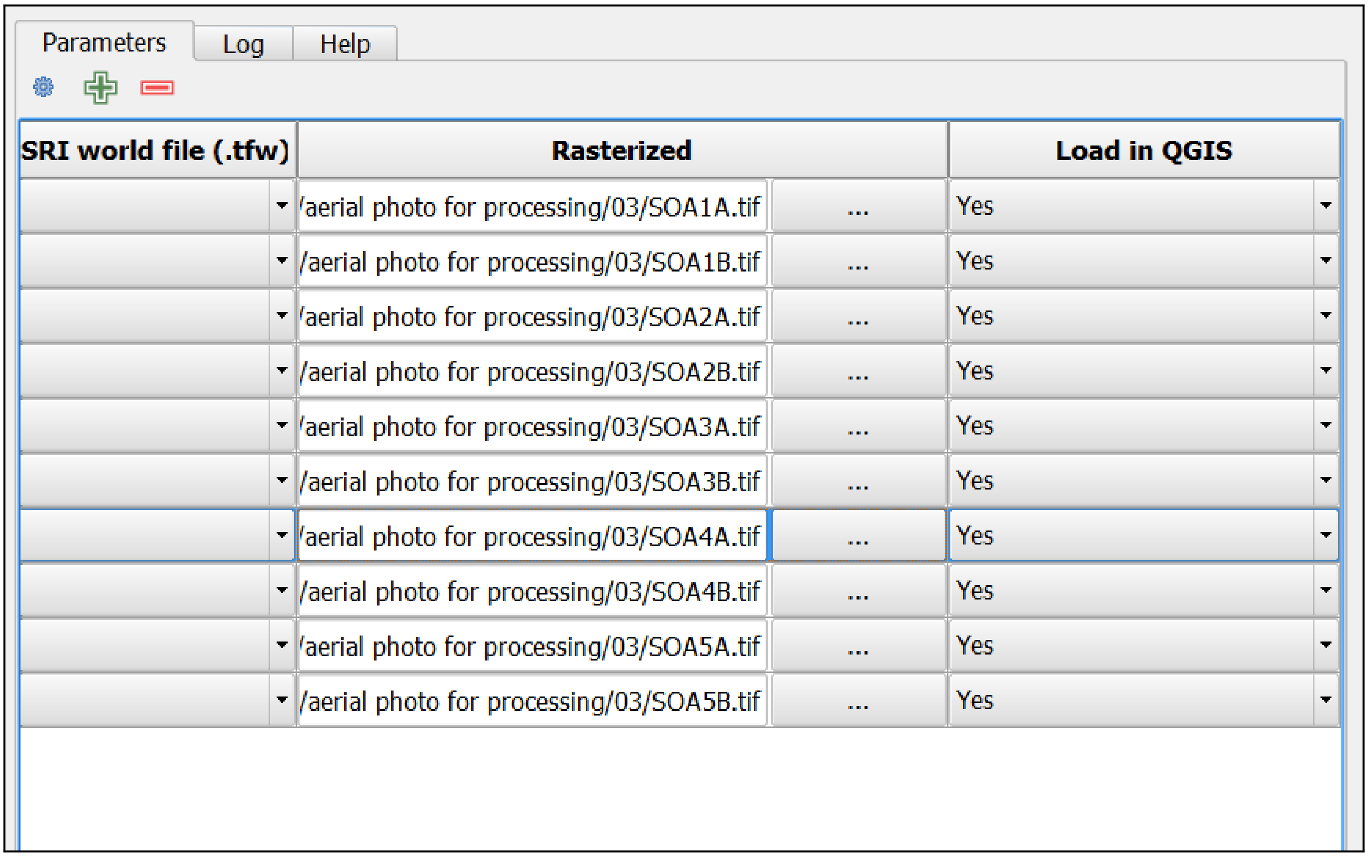


Merging Classified Vector and Convert to Raster

Step 98.

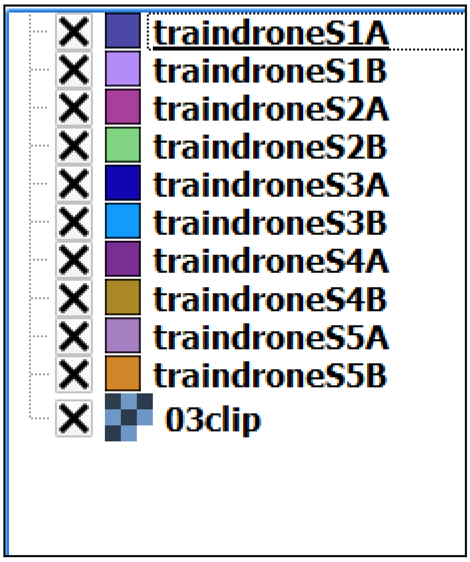
Also dissolve and convert (without using the batch process) the manual-rule result using same step.

Pixel-based Maximum Likelihood and Spectral Angle Mapping Classification

Step 99.

This example is using drone image with 10 classes.

Open the clipped drone image and ROI sets "traindroneS1A" to "traindroneS5B.



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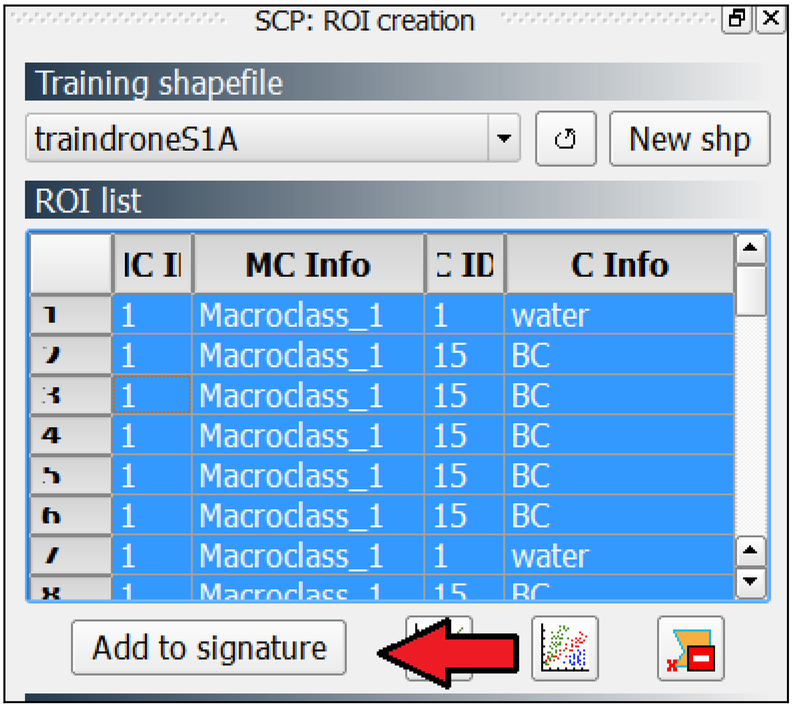
Pixel-based Maximum Likelihood and Spectral Angle Mapping Classification

Step 100.

On “SCP: ROI creation” panel, Choose “traindroneS1A” as the training shapefile. Click “Add to signature”. Wait around 30 minutes to 1 hour



Pixel-based Maximum Likelihood and Spectral Angle Mapping Classification

Step 101.

On the “SCP: Classification” Panel, save the signature file and give a name (“sigdrone1A.xml”). On the “Select Classification algorithm”, choose “Maximum Likelihood”. Then click on the “Perform Classification”. Give the file name “DSPML1A”. Wait until the process is finished (around 45 minutes to 1 hour).

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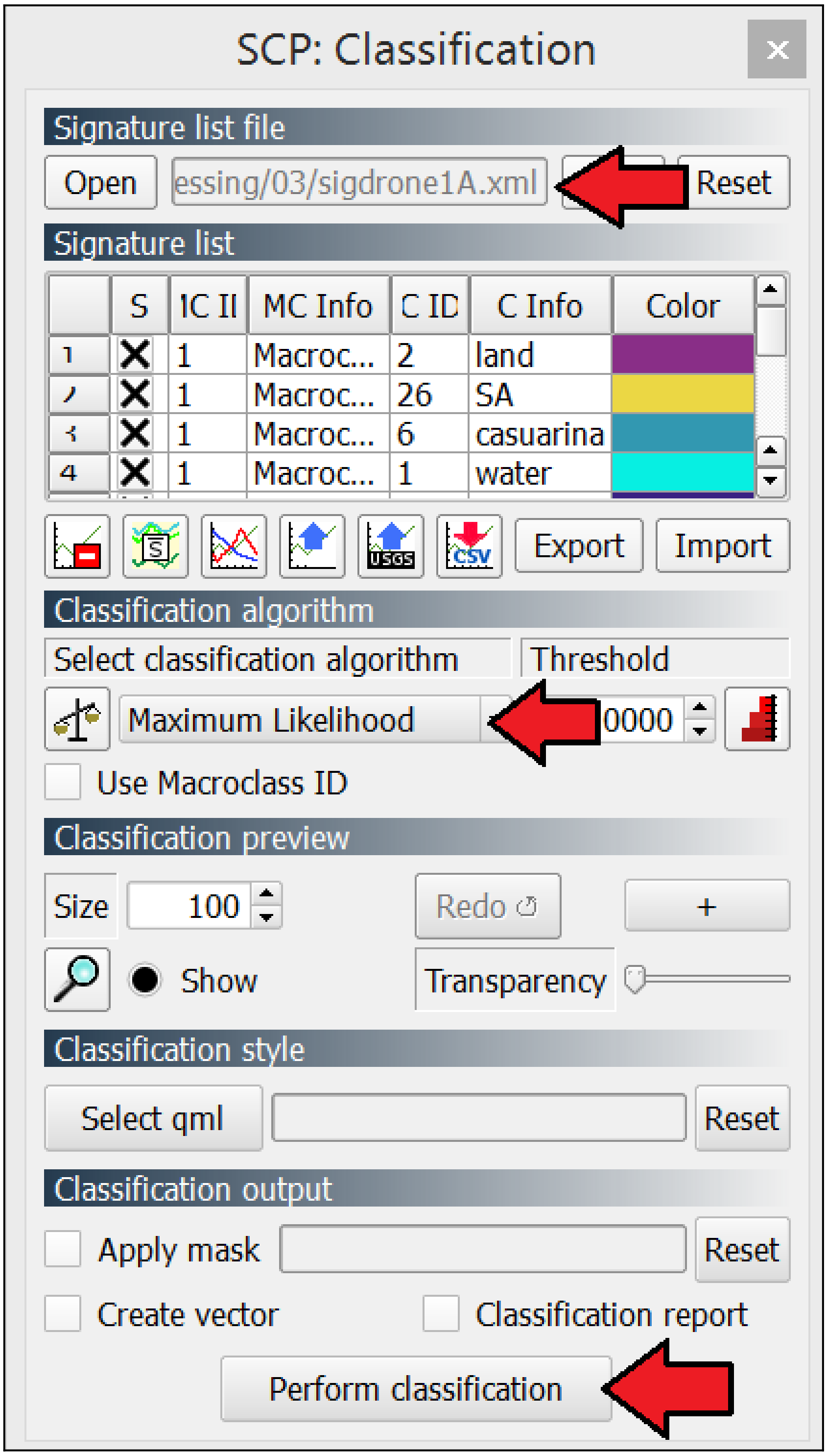

Pixel-based Maximum Likelihood and Spectral Angle Mapping Classification

Step 102.

Repeat step 3, but change the classification algorithm to Spectral Angle Mapping and save the filename as "DSPSAM1A".

Pixel-based Maximum Likelihood and Spectral Angle Mapping Classification

Step 103.

Repeat from step 2-4 for different ROI, from "traindroneS1B" to "traindroneS5B"

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Accuracy Analysis

Step 104.

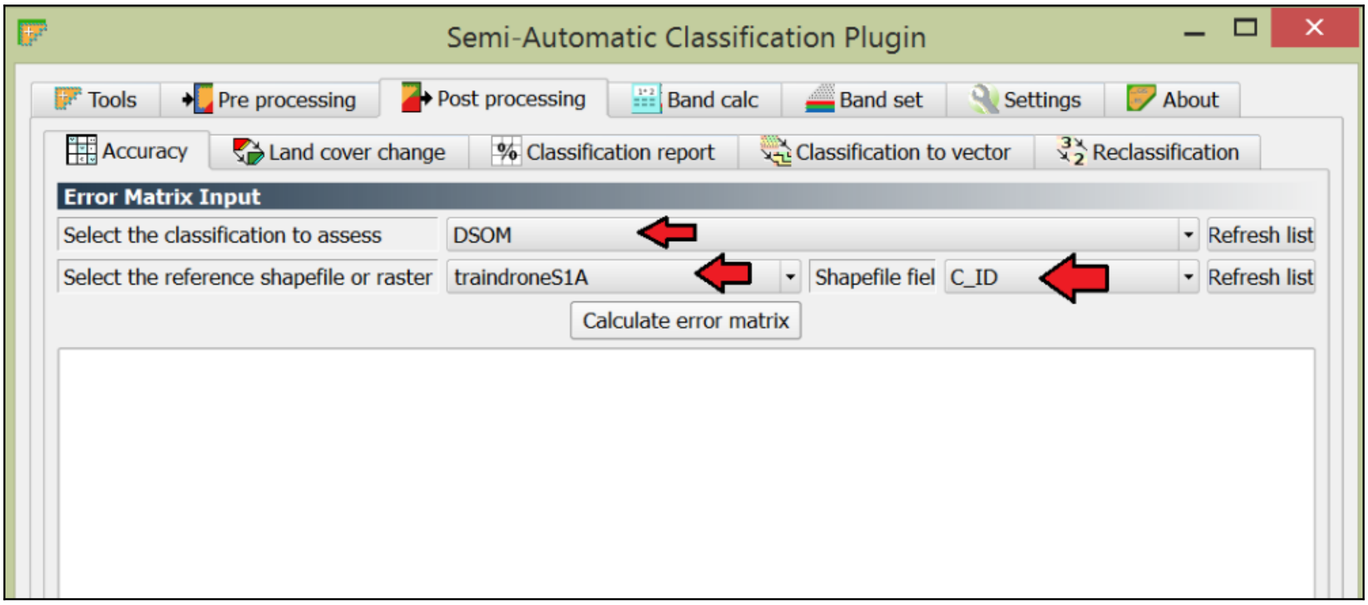
In this example, we are assessing the Drone Manual-rule results.

Click on the icon “Post Processing” in SCP Toolbar .

Accuracy Analysis

Step 105.

Choose classification result file (in this case named “DSOM”) as classification to assess, and the training site “traindroneS1A” as reference. Choose “C_ID” on the Shapefile field. Click Calculate Error Matrix. Give the filename to results “DSOM1A”



Accuracy Analysis

Step 106.

This will resulting in an error matrix. Result also availablein a .csv document, located in the same directory. This “accDSOM1A.csv” can be opened in Microsoft Excel.

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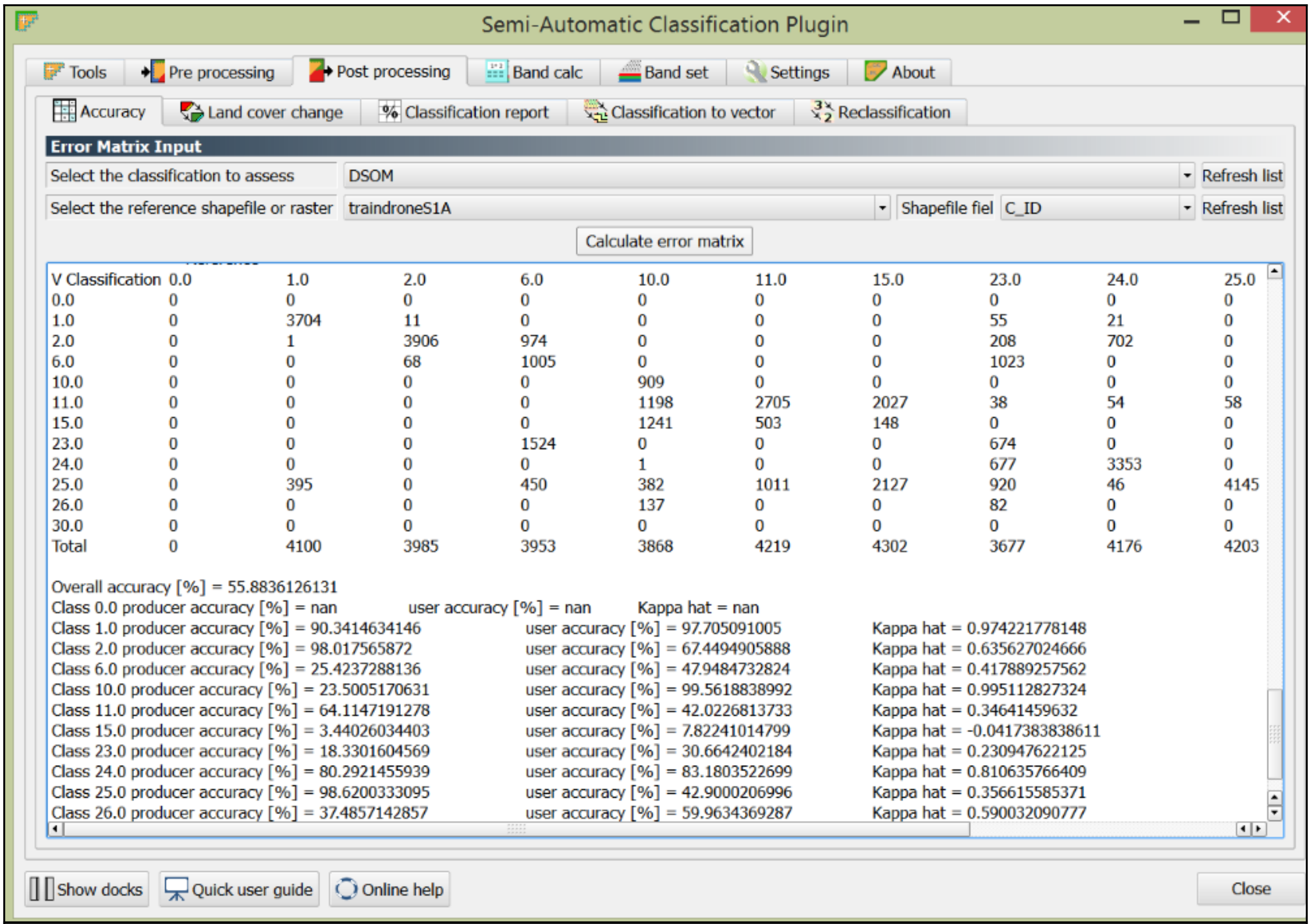
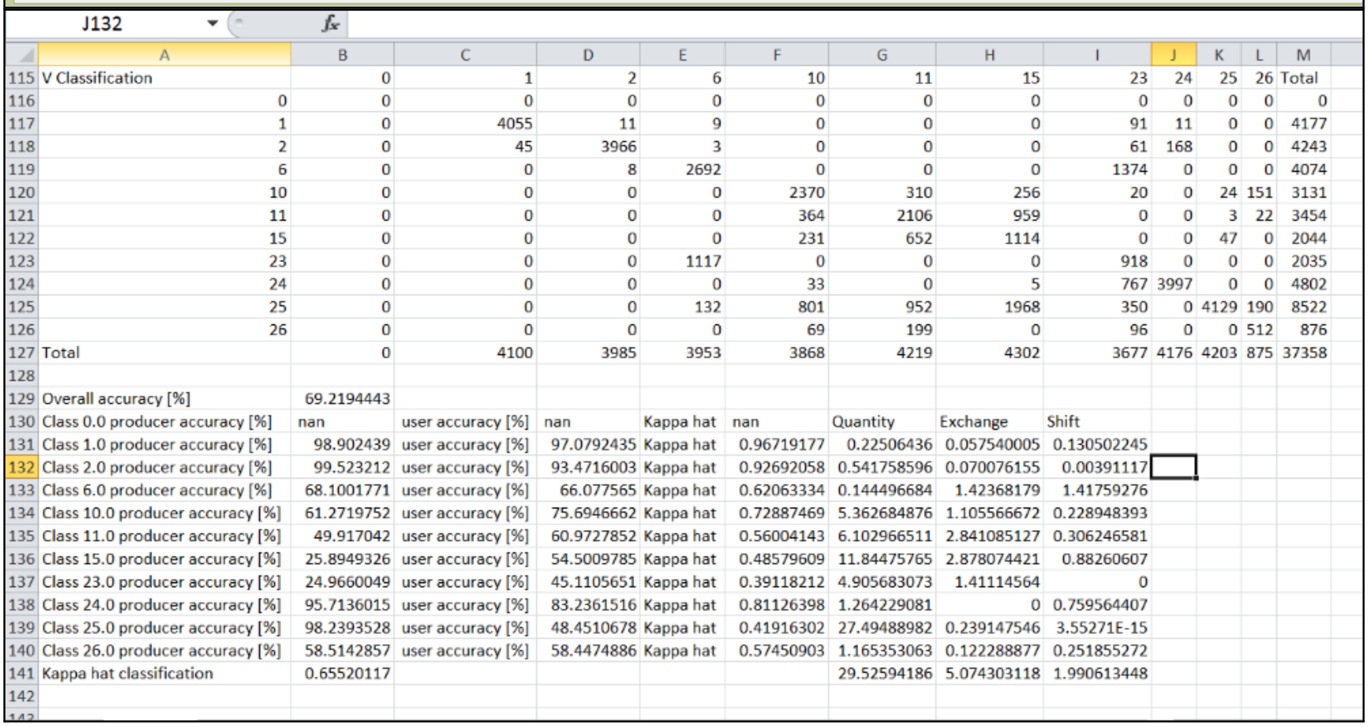


V Classification	0.0	1.0	2.0	6.0	10.0	11.0	15.0	23.0	24.0	25.0
0.0	0	0	0	0	0	0	0	0	0	0
1.0	0	3704	11	0	0	0	0	55	21	0
2.0	0	1	3906	974	0	0	0	208	702	0
6.0	0	0	68	1005	0	0	0	1023	0	0
10.0	0	0	0	0	909	0	0	0	0	0
11.0	0	0	0	0	1198	2705	2027	38	54	58
15.0	0	0	0	0	1241	503	148	0	0	0
23.0	0	0	0	1524	0	0	0	674	0	0
24.0	0	0	0	0	1	0	0	677	3353	0
25.0	0	395	0	450	382	1011	2127	920	46	4145
26.0	0	0	0	0	137	0	0	82	0	0
30.0	0	0	0	0	0	0	0	0	0	0
Total	0	4100	3985	3953	3868	4219	4302	3677	4176	4203

Overall accuracy [%] = 55.8836126131
Class 0.0 producer accuracy [%] = nan user accuracy [%] = nan Kappa hat = nan
Class 1.0 producer accuracy [%] = 90.3414634146 user accuracy [%] = 97.705091005 Kappa hat = 0.974221778148
Class 2.0 producer accuracy [%] = 98.017565872 user accuracy [%] = 67.4494905888 Kappa hat = 0.635627024666
Class 6.0 producer accuracy [%] = 25.4237288136 user accuracy [%] = 47.9484732824 Kappa hat = 0.417889257562
Class 10.0 producer accuracy [%] = 23.5005170631 user accuracy [%] = 99.5618838992 Kappa hat = 0.995112827324
Class 11.0 producer accuracy [%] = 64.1147191278 user accuracy [%] = 42.0226813733 Kappa hat = 0.34641459632
Class 15.0 producer accuracy [%] = 3.44026034403 user accuracy [%] = 7.82241014799 Kappa hat = -0.0417383838611
Class 23.0 producer accuracy [%] = 18.3301604569 user accuracy [%] = 30.6642402184 Kappa hat = 0.230947622125
Class 24.0 producer accuracy [%] = 80.2921455939 user accuracy [%] = 83.1803522699 Kappa hat = 0.810635766409
Class 25.0 producer accuracy [%] = 98.6200333095 user accuracy [%] = 42.9000206996 Kappa hat = 0.356615585371
Class 26.0 producer accuracy [%] = 37.4857142857 user accuracy [%] = 59.9634369287 Kappa hat = 0.590032090777



	A	B	C	D	E	F	G	H	I	J	K	L	M
115	V Classification	0	1	2	6	10	11	15	23	24	25	26	Total
116	0	0	0	0	0	0	0	0	0	0	0	0	0
117	1	0	4055	11	9	0	0	0	91	11	0	0	4177
118	2	0	45	3966	3	0	0	0	61	168	0	0	4243
119	6	0	0	8	2692	0	0	0	1374	0	0	0	4074
120	10	0	0	0	0	2370	310	256	20	0	24	151	3131
121	11	0	0	0	0	364	2106	959	0	0	3	22	3454
122	15	0	0	0	0	231	652	1114	0	0	47	0	2044
123	23	0	0	0	1117	0	0	0	918	0	0	0	2035
124	24	0	0	0	0	33	0	5	767	3997	0	0	4802
125	25	0	0	0	132	801	952	1968	350	0	4129	190	8522
126	26	0	0	0	0	69	199	0	96	0	0	512	876
127	Total	0	4100	3985	3953	3868	4219	4302	3677	4176	4203	875	37358
128													
129	Overall accuracy [%]	69.2194443											
130	Class 0.0 producer accuracy [%]	nan	user accuracy [%]	nan	Kappa hat	nan	Quantity	Exchange	Shift				
131	Class 1.0 producer accuracy [%]	98.902439	user accuracy [%]	97.0792435	Kappa hat	0.96719177	0.22506436	0.057540005	0.130502245				
132	Class 2.0 producer accuracy [%]	99.523212	user accuracy [%]	93.4716003	Kappa hat	0.92692058	0.541758596	0.070076155	0.00391117				
133	Class 6.0 producer accuracy [%]	68.1001771	user accuracy [%]	66.077565	Kappa hat	0.62063334	0.144496684	1.42368179	1.41759276				
134	Class 10.0 producer accuracy [%]	61.2719752	user accuracy [%]	75.6946662	Kappa hat	0.72887469	5.362684876	1.105566672	0.228948393				
135	Class 11.0 producer accuracy [%]	49.917042	user accuracy [%]	60.9727852	Kappa hat	0.56004143	6.102966511	2.841085127	0.306246581				
136	Class 15.0 producer accuracy [%]	25.8949326	user accuracy [%]	54.5009785	Kappa hat	0.48579609	11.84475765	2.878074421	0.88260607				
137	Class 23.0 producer accuracy [%]	24.9660049	user accuracy [%]	45.1105651	Kappa hat	0.39118212	4.905683073	1.41114564	0				
138	Class 24.0 producer accuracy [%]	95.7136015	user accuracy [%]	83.2361516	Kappa hat	0.81126398	1.264229081	0	0.759564407				
139	Class 25.0 producer accuracy [%]	98.2393528	user accuracy [%]	48.4510678	Kappa hat	0.41916302	27.49488982	0.239147546	3.55271E-15				
140	Class 26.0 producer accuracy [%]	58.5142857	user accuracy [%]	58.4474886	Kappa hat	0.57450903	1.165353063	0.122288877	0.251855272				
141	Kappa hat classification	0.65520117					29.52594186	5.074303118	1.990613448				
142													

Accuracy Analysis

Step 107.

Repeat the process for all ROIs and all classified image. For Manual rule, test them with each ROI. For other classification (Automatic/OGR, ML and SAM), test them with complimentary training file (1A tested by 1B,

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3B tested by 3A and so on)

Pontius Matrix

Step 108.

Download the Pontius Matrix Excel file from http://www2.clarku.edu/rpontius/PontiusMatrix41.xlsx

Pontius Matrix

Step 109.

On the tab Sample Count, rename the category into the classes names (water, land etc)

C3 | fx | water

A	B	C	D	E	F	G	H	I	J	K	L	M
Sample	DomainName		Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Population		Error	water	land	casuarina	deadtree	AA	BC	LR	NF	RA	SA
	Comparison	water										
	Comparison	land										
	Comparison	casuarina										
	Comparison	deadtree										
	Comparison	AA										
	Comparison	BC										
	Comparison	LR										
	Comparison	NF										
	Comparison	RA										
	Comparison	SA										

documentation / SampleCount / PopulationCount / Proportion / Transpose / Exchange / FiguresData / OverallSources / OverallComponents / CategorySources / CategoryComp

Count: 10 100%

Pontius Matrix

Step 110.

Copy and paste the error matrix into Pontius.

A	B	C	D	E	F	G	H	I	J	K	L	M
Sample	DomainName		Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Population		Error	water	land	casuarina	deadtree	AA	BC	LR	NF	RA	SA
	Comparison	water	4055	11	9	0	0	0	91	11	0	0
	Comparison	land	45	3966	3	0	0	0	61	168	0	0
	Comparison	casuarina	0	8	2692	0	0	0	1374	0	0	0
	Comparison	deadtree	0	0	0	2370	310	256	20	0	24	151
	Comparison	AA	0	0	0	364	2106	959	0	0	3	22
	Comparison	BC	0	0	0	231	652	1114	0	0	47	0
	Comparison	LR	0	0	1117	0	0	0	918	0	0	0
	Comparison	NF	0	0	0	33	0	5	767	3997	0	0
	Comparison	RA	0	0	132	801	952	1968	350	0	4129	190
	Comparison	SA	0	0	0	69	199	0	96	0	0	512

Pontius Matrix

Step 111.

For sample population, open QGIS and open the classified map (in this case “DSOM”). On the “Processing Toolbox”, chose “r.report” algorithm.

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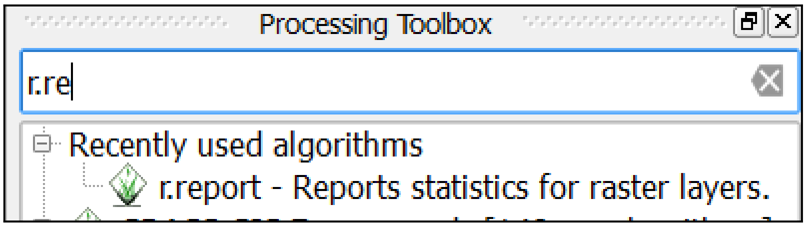
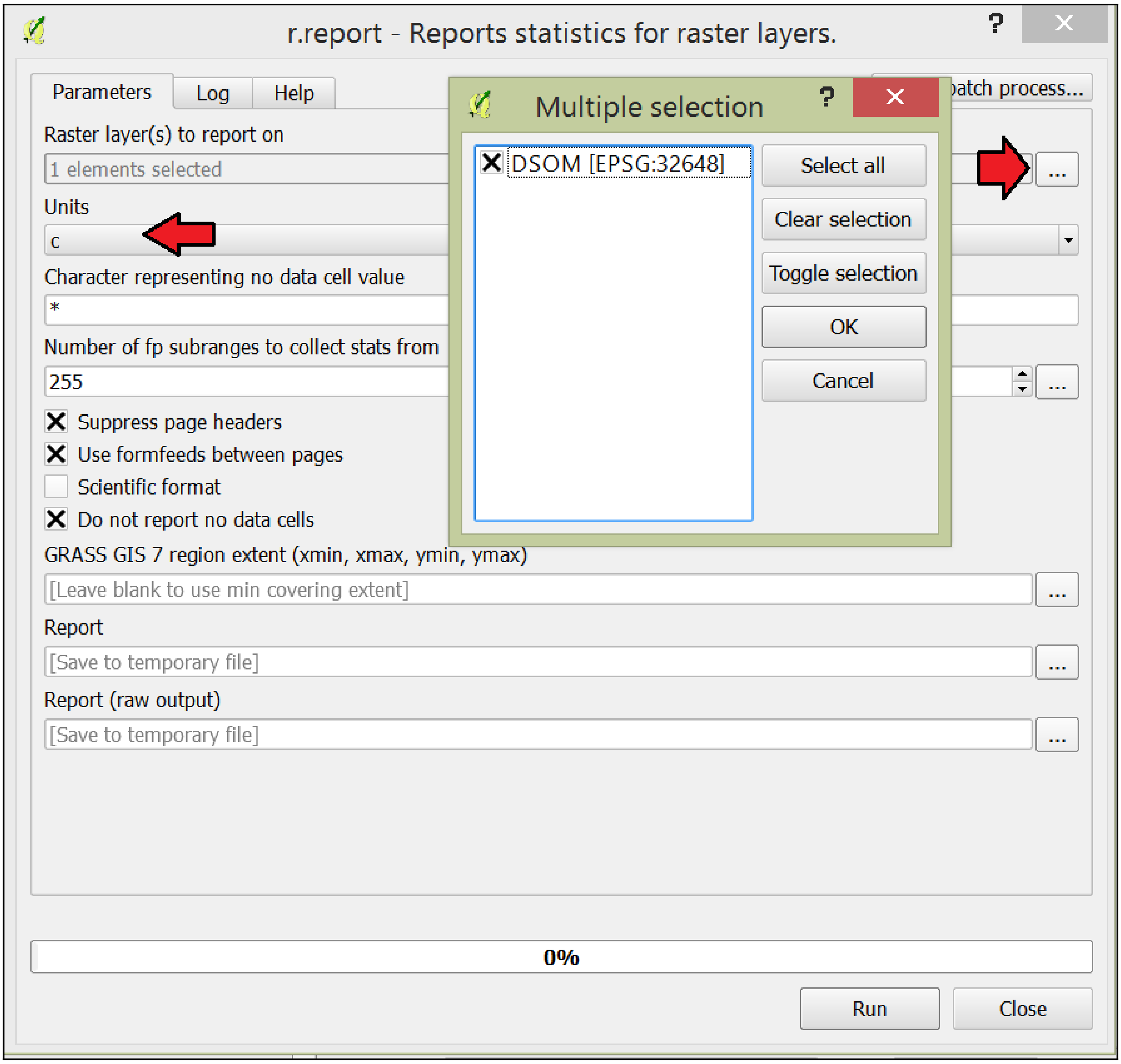


Pontius Matrix

Step 112.

Select “DSOM” as raster layer to report on. Select “c” or cell count as unit. Click “Run”.



Pontius Matrix

Step 113.

Copy the cell count (leave the value 0 as it is unclassified) then paste it into pontius matrix.

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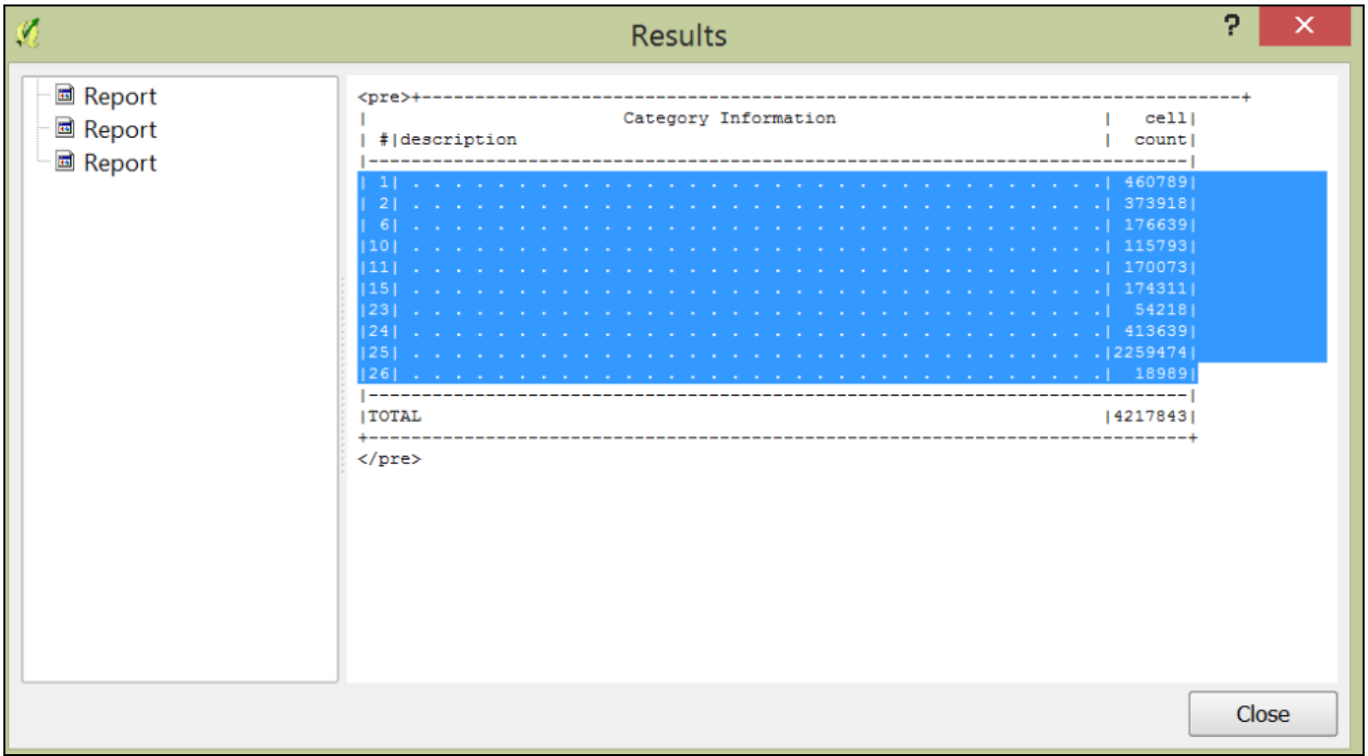

Sample	DomainName		Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Population		Error	water	land	casuarina	deadtree	AA	BC	LR	NF	RA	SA
460789	Comparison	water	4055	11	9	0	0	0	91	11	0	0
373918	Comparison	land	45	3966	3	0	0	0	61	168	0	0
176639	Comparison	casuarina	0	8	2692	0	0	0	1374	0	0	0
115793	Comparison	deadtree	0	0	0	2370	310	256	20	0	24	151
170073	Comparison	AA	0	0	0	364	2106	959	0	0	3	22
174311	Comparison	BC	0	0	0	231	652	1114	0	0	47	0
54218	Comparison	LR	0	0	1117	0	0	0	918	0	0	0
413639	Comparison	NF	0	0	0	33	0	5	767	3997	0	0
2259474	Comparison	RA	0	0	132	801	952	1968	350	0	4129	190
18989	Comparison	SA	0	0	0	69	199	0	96	0	0	512

Pontius Matrix

Step 114.

On the tab “Figures Data”, Quantity, Exchange and Shift values can be obtained.

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B	C	D	E	F	G	H	I	
ission	Agreement	Commission	Sign	Quantity	Exchange	Shift	Figure Of Merit	On
0	11	0	-	0.22506	0.05754	0.13050	96	
0	8	1	-	0.54176	0.07008	0.00391	93	
2	3	1	+	0.14450	1.42368	1.41759	48	
6	2	1	+	5.36268	1.10557	0.22895	24	
8	2	2	+	6.10297	2.84109	0.30625	21	
14	2	2	+	11.84476	2.87807	0.88261	13	
6	1	1	+	4.90568	1.41115	0.00000	8	
0	8	2	-	1.26423	0.00000	0.75956	80	
0	26	28	-	27.49489	0.23915	0.00000	48	
1	0	0	+	1.16535	0.12229	0.25186	15	
37	63	37		29.52594	5.07430	1.99061		

on | SampleCount | PopulationCount | Proportion | Transpose | Exchange | **FiguresData** | O

Pontius Matrix

Step 115.

On the tab “Category Component”, we could see which class is over or underestimate. Here the dead tree quantity is overestimated and land quantity is underestimated.

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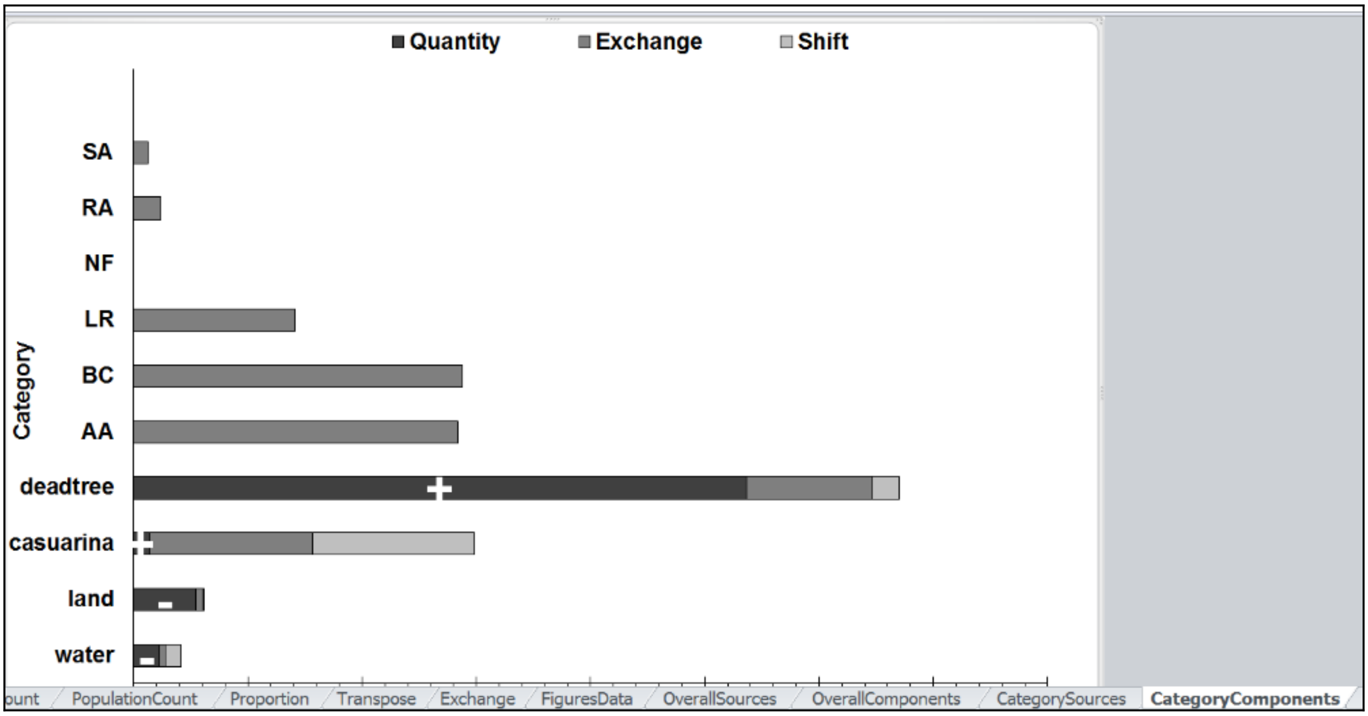

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