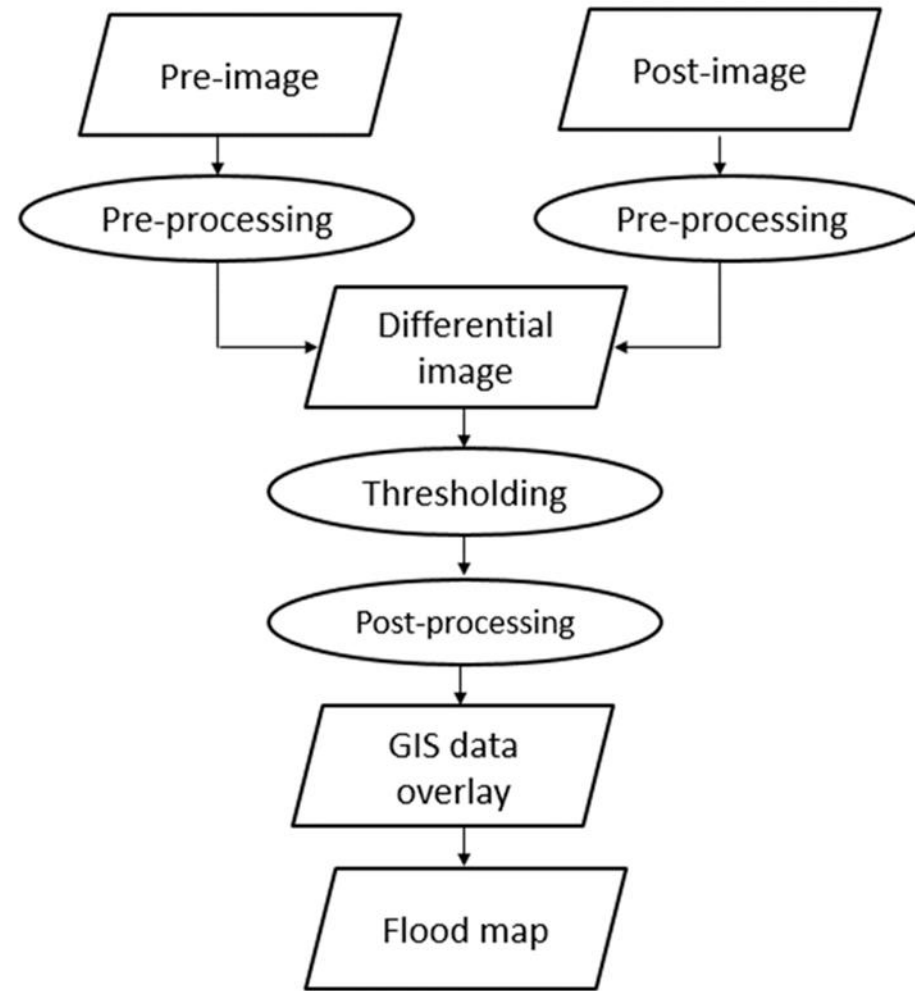


Flood Extraction Using ALOS 2 PALSAR 2 Data

Chathumal Madhuranga (AIT)

Methodology behind the Flood extraction



ALOS 2 PALSAR 2 Data Calibration

$$\sigma^0 [\text{dB}] = 10 \log_{10} (DN)^2 + CF$$

σ^0 – Radar Backscatter

DN – Pixel DN values

CF - Calibration Factor

1 Open QGIS installed on your computer

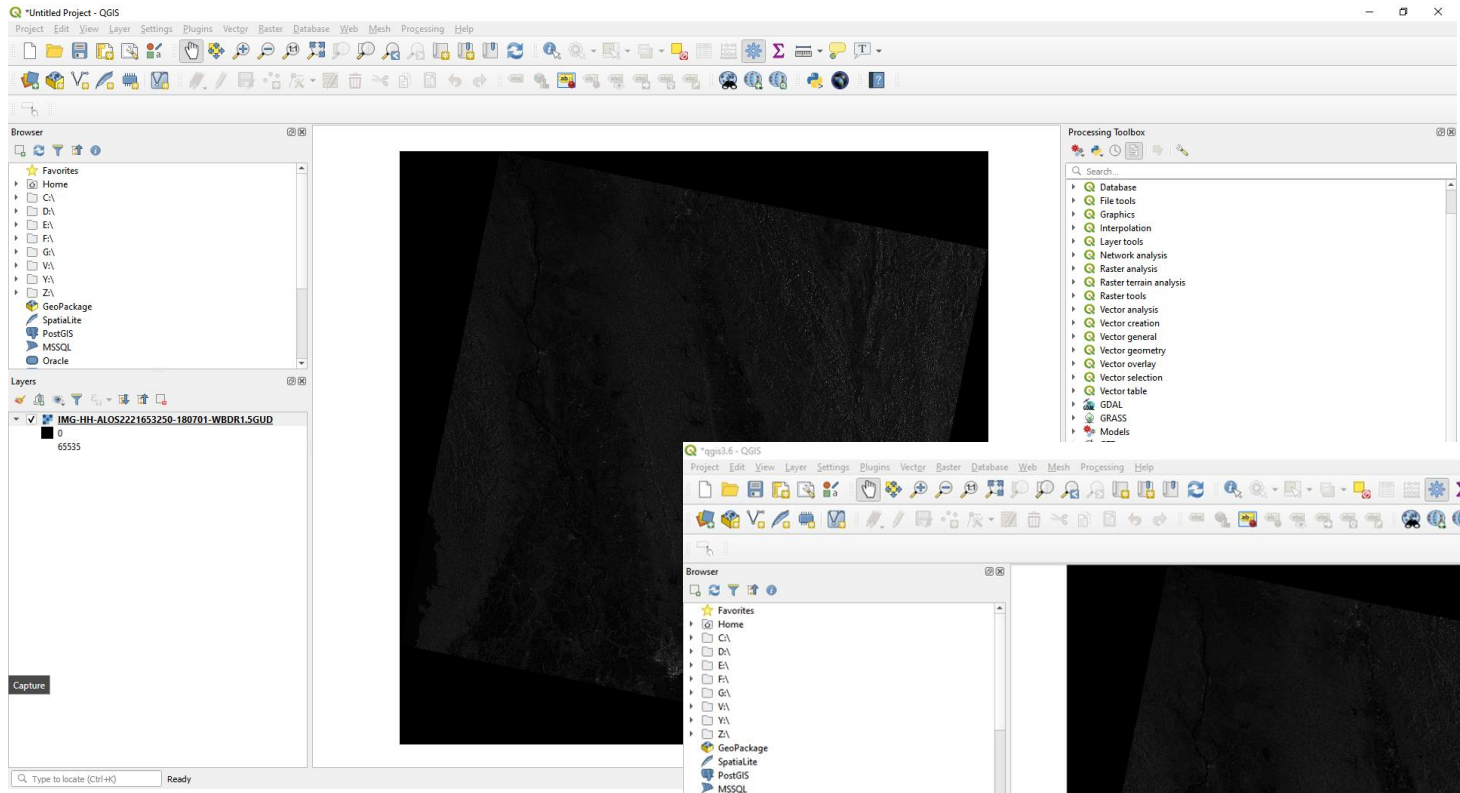
1.1 Goto Layer > Add Layer > Add Raster Layer

1.2 Browse the path to your image

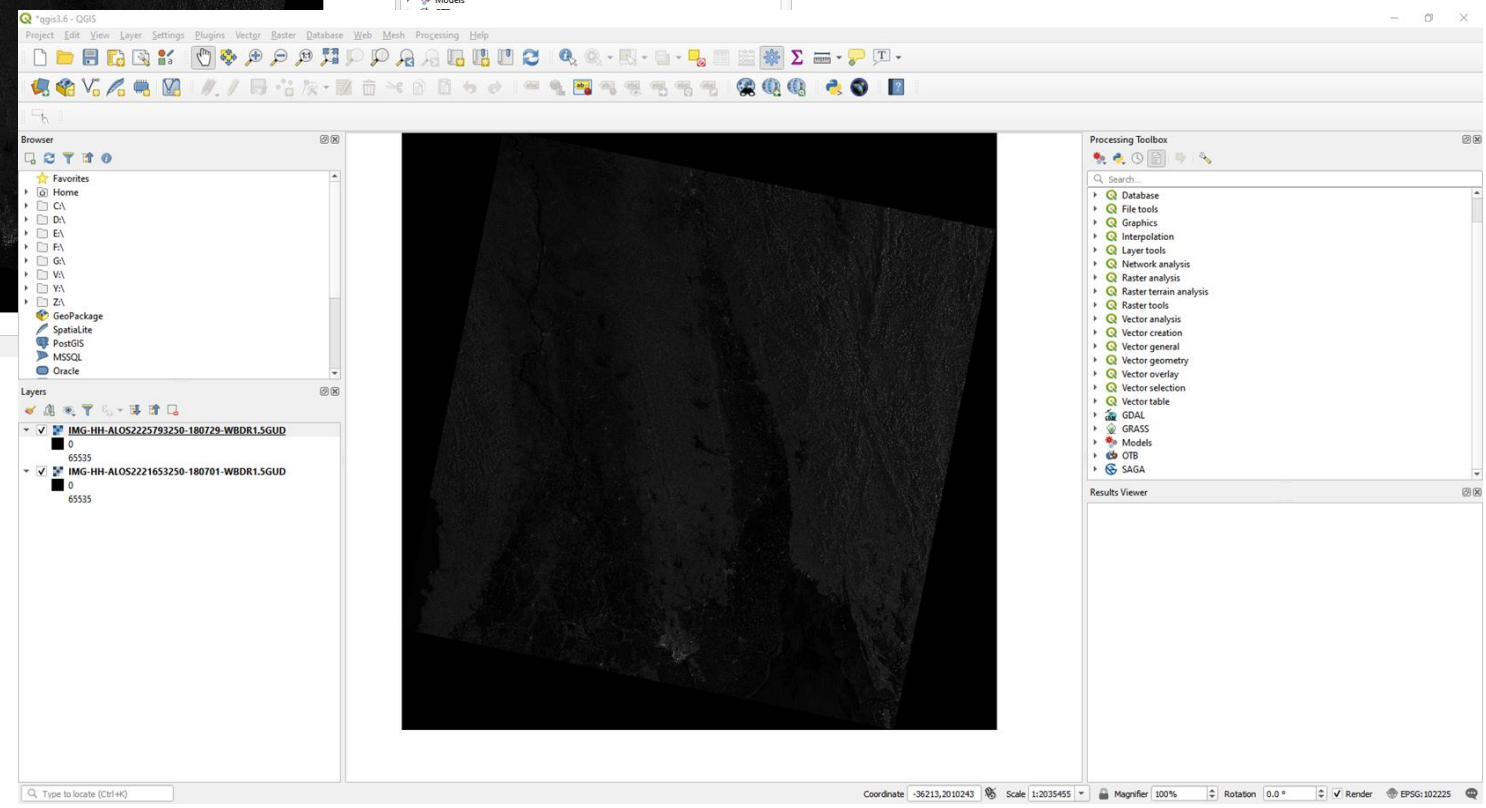
The screenshot shows the QGIS interface with the 'Data Source Manager | Raster' dialog open. The 'Source type' is set to 'File'. The 'Source' field contains the path to the raster dataset: 'Data|0000215586_001001_ALOS2221653250-180701|IMG-HH-ALOS2221653250-180701-WBDR1.5GUD.tif'. The 'Open GDAL Supported Raster Dataset(s)' dialog is also open, showing a list of files in the folder '21_JPTM_workshop > Flood_Data_Myanmar > ALOS_Data > 0000215586_001001_ALOS2221653250-180701'. The file 'IMG-HH-ALOS2221653250-180701-WBDR1.5GUD' is selected. The 'File name' field at the bottom of the file browser contains 'IMG-HH-ALOS2221653250-180701-WBDR1.5GUD'. The 'All files' option is selected in the file type dropdown.

Name	Date modified	Type	Size
ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	KML	4 KB
BRS-HH-ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	JPG File	106 KB
BRS-HV-ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	JPG File	105 KB
IMG-HH-ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	TIF File	553,937 KB
IMG-HH-ALOS2221653250-180701-WBDR1.5GUD.tif.aux	10/24/2019 10:17 PM	XML Document	1 KB
IMG-HV-ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	TIF File	553,937 KB
LUT-HH-ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	Text Document	377 KB
LUT-HV-ALOS2221653250-180701-WBDR1.5GUD	7/30/2018 9:13 AM	Text Document	377 KB
summary	7/30/2018 9:13 AM	Text Document	3 KB

1.3 Select the HH polarized image [Pre-Image (18/07/01)]

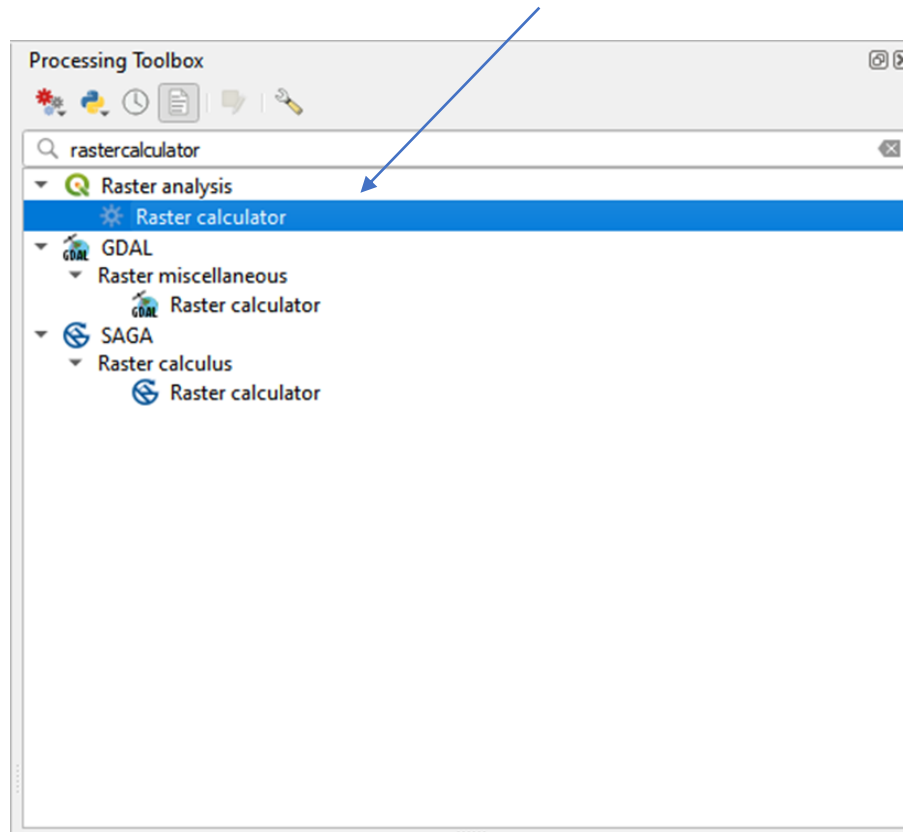


1.4 Similarly add the Post Image →
[Post-Image (18/07/29)]

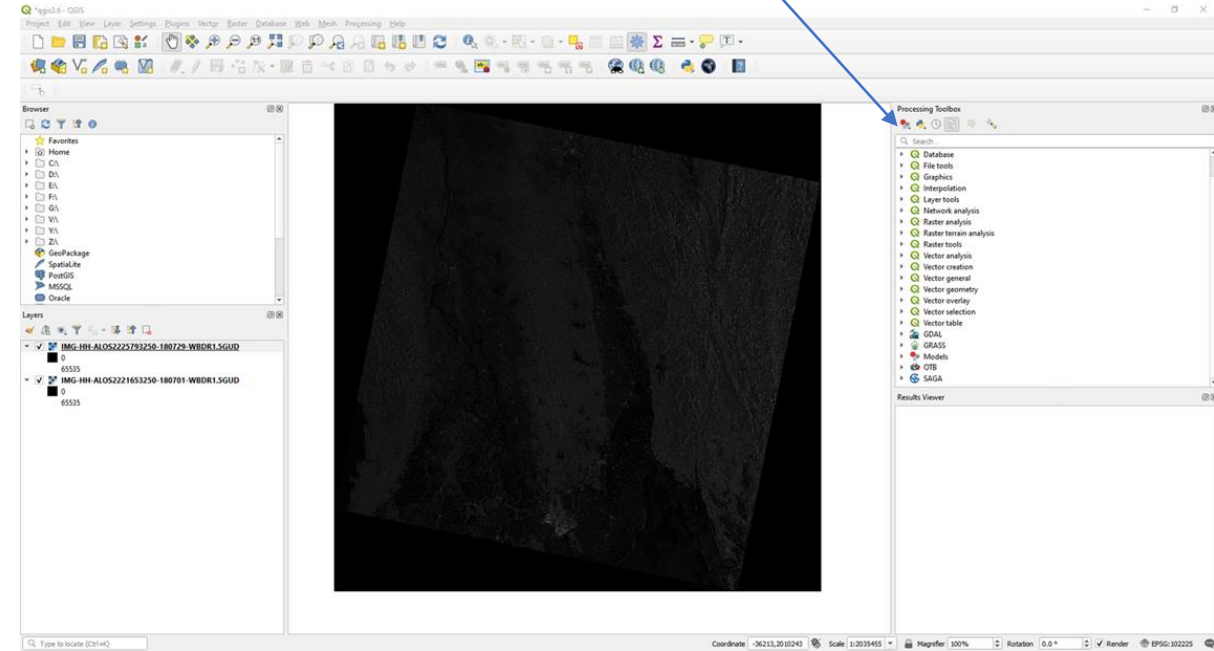


2 Image Calibration

2.2 Select the **Raster calculator** under QGIS processing tools.



2.1 In Processing toolbox search bar type raster calculator.



2.3 Input the Calibration Expression here

Raster Calculator

Parameters Log

Expression

Layers

- IMG-HH-ALOS2221653250-180701-WBDR1.5GUD@1
- IMG-HH-ALOS2225793250-180729-WBDR1.5GUD@1

Operators

Expression

(20 * log10((IMG-HH-ALOS2221653250-180701-WBDR1.5GUD@1)) - 83

Predefined expressions

NDVI

Reference layer(s) (used for automated extent, cellsize, and CRS) [optional]

1 elements selected

Cell size (use 0 or empty to set it automatically) [optional]

0.000000

Output extent (xmin, xmax, ymin, ymax) [optional]

[Leave blank to use min covering extent]

Output CRS [optional]

Project CRS: EPSG:102225 - MONREF_1997_UTM_Zone_47N

Output

D:/2019/21_JPTM_workshop/Results/Pre_Calib.tif

Open output file after running algorithm

0%

Run as Batch Process...

Run Close Help

Raster calculator

This algorithm allows performing algebraic operations using raster layers.

The resulting layer will have its values computed according to an expression. The expression can contain numerical values, operators and references to any of the layers in the current project. The following functions are also supported:

- sin(), cos(), tan(), atan2(), ln(), log10()

The extent, cell size, and output CRS can be defined by the user. If the extent is not specified, the minimum extent that covers selected reference layer(s) will be used. If the cell size is not specified, the minimum cell size of selected reference layer(s) will be used. If the output CRS is not specified, the CRS of the first reference layer will be used.

The cell size is assumed to be the same in both X and Y axes.

Layers are referred by their name as displayed in the layer list and the number of the band to use (based on 1), using the pattern 'layer_name@band number'. For instance, the first band from a layer named DEM will be referred as DEM@1.

When using the calculator in the batch interface or from the console, the files to use have to be specified. The corresponding layers are referred using the base name of the file (without the full path). For instance, if using a layer at path/to/my/rasterfile.tif, the first band of that layer will be referred as rasterfile.tif@1.

2.4 Click on this icon and select a reference layer

2.5 Browse to the output folder and give it a name and save it as a .tif file

2.7 Click Run

Raster Calculator

Parameters Log

Expression

Layers

- IMG-HH-ALOS2221653250-180701-WBDR1.5GUD@1
- IMG-HH-ALOS2225793250-180729-WBDR1.5GUD@1

Operators

Expression

(20 * log10((IMG-HH-ALOS2221653250-180701-WBDR1.5GUD@1)) - 83

Predefined expressions

NDVI

Reference layer(s) (used for automated extent, cellsize, and CRS) [optional]

1 elements selected

Cell size (use 0 or empty to set it automatically) [optional]

0.000000

Output extent (xmin, xmax, ymin, ymax) [optional]

[Leave blank to use min covering extent]

Output CRS [optional]

Project CRS: EPSG:102225 - MONREF_1997_UTM_Zone_47N

Output

D:/2019/21_JPTM_workshop/Results/Pre_Calib.tif

Open output file after running algorithm

0%

Run as Batch Process...

Run Close Help

2.6 Click OK

Multiple selection

- IMG-HH-ALOS2221653250-180701-WBDR1.5GUD [EPSG:102225]
- IMG-HH-ALOS2225793250-180729-WBDR1.5GUD [EPSG:102225]

Select All

Clear Selection

Toggle Selection

Add File(s)...

OK

Cancel

7

2.8 Do the same calibration for the post image

Raster Calculator

Parameters Log

Expression

Layers

- IMG-HH-ALOS2221653250-180701-WBDR1.5GUD@1
- IMG-HH-ALOS2225793250-180729-WBDR1.5GUD@1

Operators

+	*	cos	sin	log10	AND
-	/	acos	asin	ln	OR
^	sqrt	tan	atan	()
<	>	=	!=	<=	>=

Expression

```
(20*log10('IMG-HH-ALOS2225793250-180729-WBDR1.5GUD@1')) - 83
```

Predefined expressions

NDVI Add... Save...

Reference layer(s) (used for automated extent, cellsize, and CRS) [optional]
1 elements selected

Cell size (use 0 or empty to set it automatically) [optional]
0.000000

Output extent (xmin, xmax, ymin, ymax) [optional]
[Leave blank to use min covering extent]

Output CRS [optional]
Project CRS: EPSG:102225 - MONREF_1997_UTM_Zone_47N

Output
D:/2019/21_JPTM_workshop/Results/Post_Calb.tif

Open output file after running algorithm

0%

Run as Batch Process... Run Close Help

Raster calculator

This algorithm allows performing algebraic operations using raster layers.

The resulting layer will have its values computed according to an expression. The expression can contain numerical values, operators and references to any of the layers in the current project. The following functions are also supported:

- sin(), cos(), tan(), atan2(), ln(), log10()

The extent, cell size, and output CRS can be defined by the user. If the extent is not specified, the minimum extent that covers selected reference layer(s) will be used. If the cell size is not specified, the minimum cell size of selected reference layer(s) will be used. If the output CRS is not specified, the CRS of the first reference layer will be used.

The cell size is assumed to be the same in both X and Y axes.

Layers are referred by their name as displayed in the layer list and the number of the band to use (based on 1), using the pattern 'layer_name@band number'. For instance, the first band from a layer named DEM will be referred as DEM@1.

When using the calculator in the batch interface or from the console, the files to use have to be specified. The corresponding layers are referred using the base name of the file (without the full path). For instance, if using a layer at path/to/my/rasterfile.tif, the first band of that layer will be referred as rasterfile.tif@1.

3 Speckle filtering

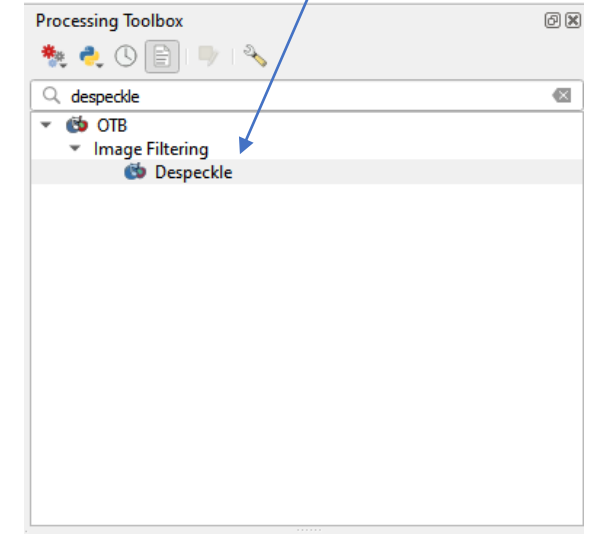
3.1 Type **Despeckle** in processing toolbox search bar Select the Despeckle in OTB toolbox.

3.2 Select the calibrated **pre-image** from the drop down.

3.3 Select the filter type as **Lee**

3.4 Specify radius of the filter as **1** (3*3)

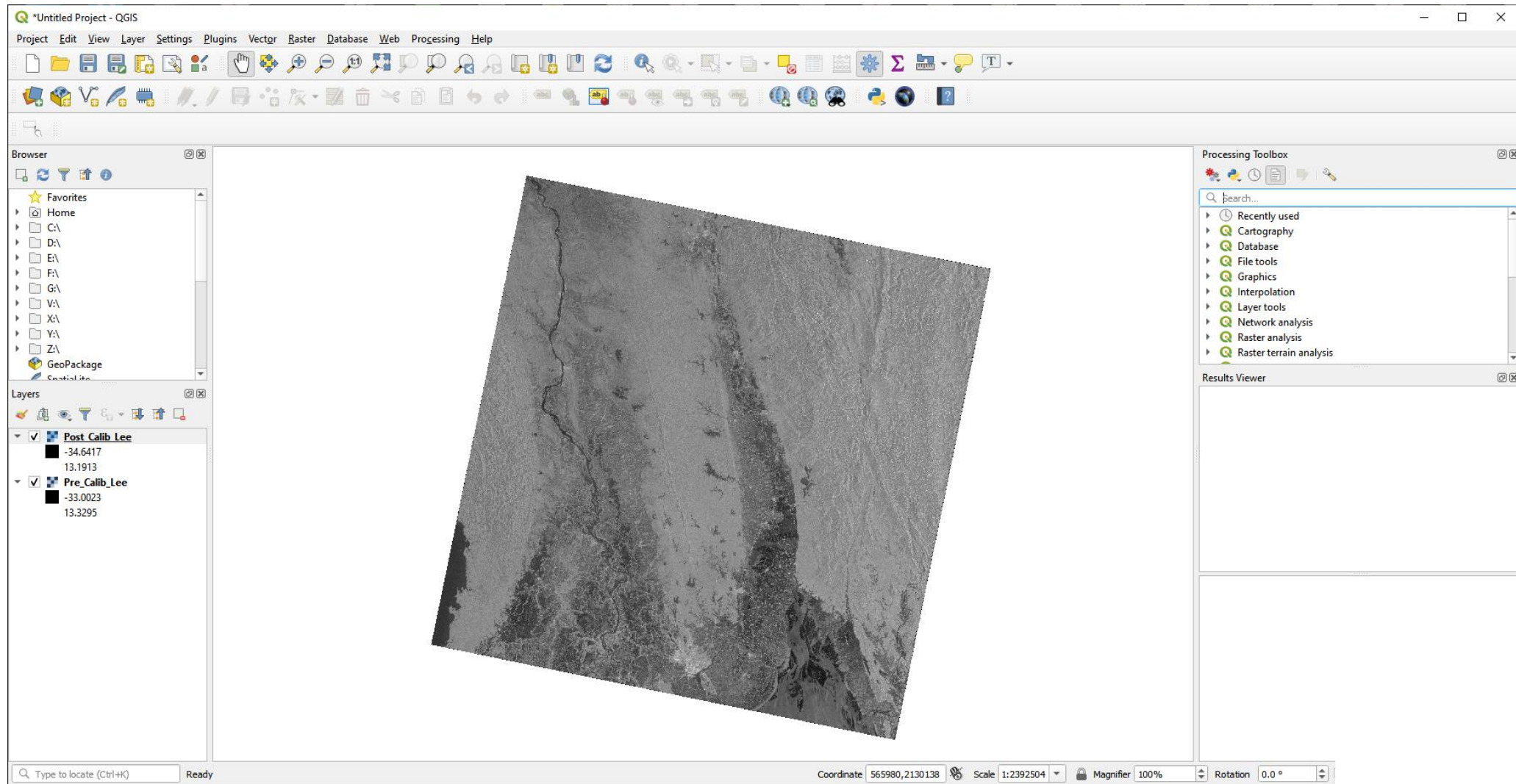
3.5 Browse to output folder and give it a relevant name and **.tif** file type



3.6 Click **Run**

Do the same process for the **post image**

Images after speckle filtering



4 Re-project images into WGS84 system

4.1 Type **Warp** in processing toolbox search bar Select the Warp under **GDAL**

4.2 Select the filtered **pre-image** from the drop down.

4.3 Select the Target CRS as EPSG: 4326

4.4 Specify the resampling as Nearest neighbor

4.5 Browse to output folder and give it a relevant name and **.tif** file type

The screenshot shows the QGIS Processing Toolbox on the right and the 'Warp (Reproject)' dialog box on the left. The toolbox search bar contains 'Warp', and the 'Warp (reproject)' tool is selected under the 'GDAL' category. The dialog box has the following settings:

- Input layer: Pre_Calib_Lee [EPSG:102225]
- Source CRS [optional]:
- Target CRS: EPSG:4326 - WGS 84
- Resampling method to use: Nearest neighbour
- Nodata value for output bands [optional]: Not set
- Output file resolution in target georeferenced units [optional]: Not set
- Advanced parameters: Reprojected
- Output file path: D:/2019/21_JPTM_workshop/New/Pre_Calib_Lee_Prj.tif
- Open output file after running algorithm:

The GDAL/OGR console call is: `gdalwarp -t_srs EPSG:4326 -r near -of GTiff D:/2019/21_JPTM_workshop/Results/Pre_Calib_Lee.tif D:/2019/21_JPTM_workshop/New/Pre_Calib_Lee_Prj.tif`

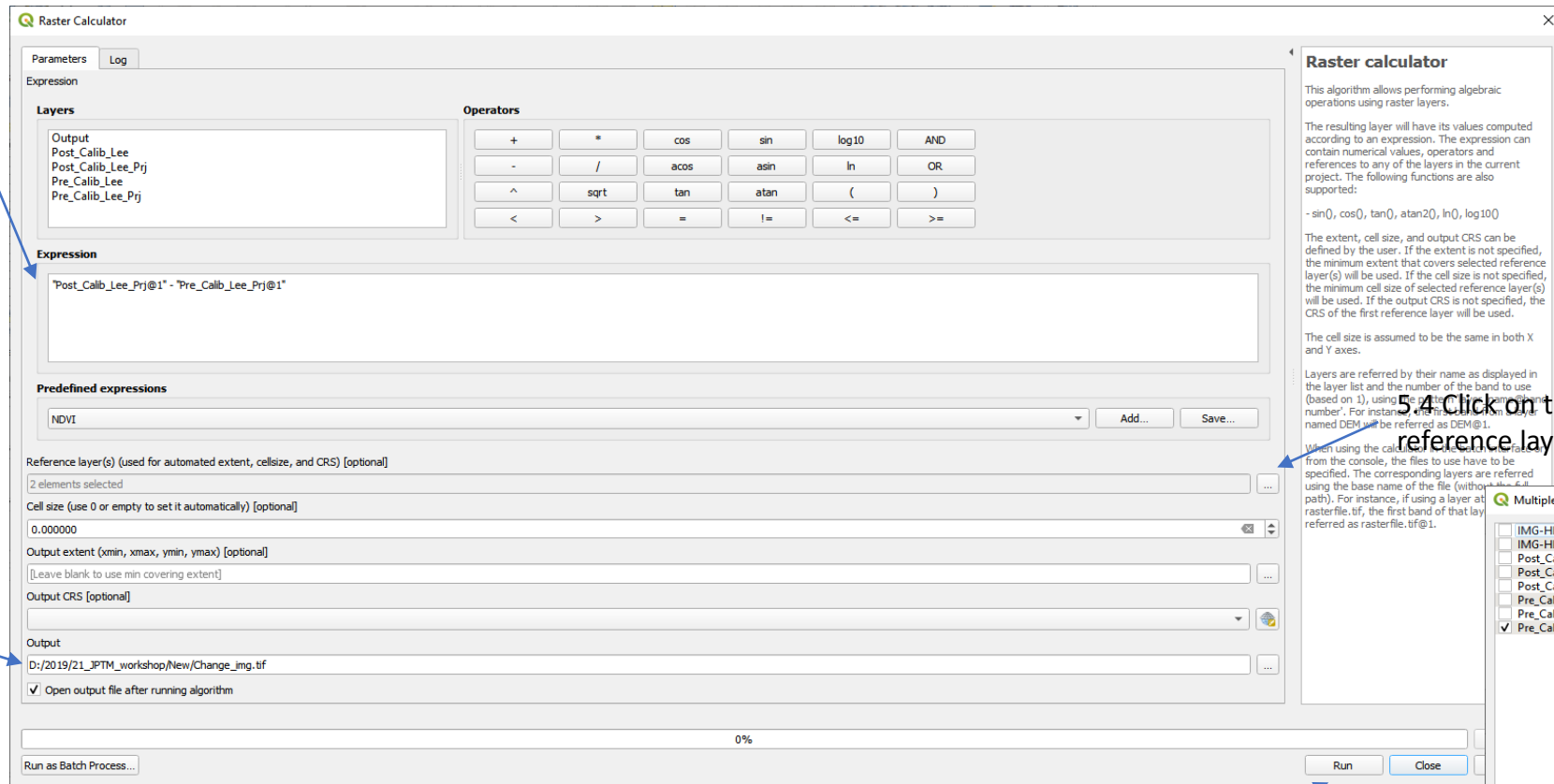
At the bottom right, the 'Run' button is highlighted with an arrow pointing to it from the text '4.6 Click Run'.

Do the same process for the **post filtered image**

5 Generating the pre-post difference image

5.1 Type **Raster calculator** in processing toolbox search bar Select the **Raster calculator** under **QGIS tools**

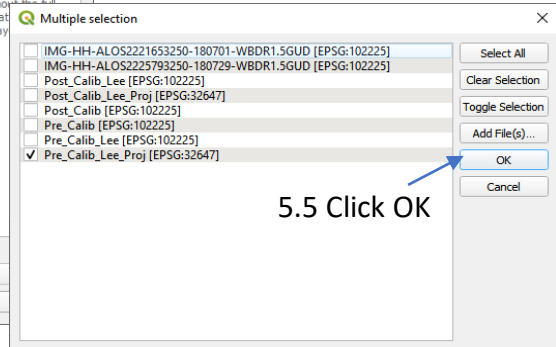
5.2 Obtain the difference between projected pre and post images by Inputting the Expression as follows



5.3 Browse to the output folder and give it a name and save it as a .tif file

Raster calculator
This algorithm allows performing algebraic operations using raster layers.
The resulting layer will have its values computed according to an expression. The expression can contain numerical values, operators and references to any of the layers in the current project. The following functions are also supported:
- sin(), cos(), tan(), atan2(), ln(), log10()
The extent, cell size, and output CRS can be defined by the user. If the extent is not specified, the minimum extent that covers selected reference layer(s) will be used. If the cell size is not specified, the minimum cell size of selected reference layer(s) will be used. If the output CRS is not specified, the CRS of the first reference layer will be used.
The cell size is assumed to be the same in both X and Y axes.
Layers are referred by their name as displayed in the layer list and the number of the band to use (based on 1), using the following format: 'layername:bandnumber'. For instance, if the layer name is 'DEM' and the first band is used, the layer will be referred as DEM@1.
When using the calculator, the files to use have to be specified. The corresponding layers are referred using the base name of the file (without the extension). For instance, if using a layer at rasterfile.tif, the first band of that layer referred as rasterfile.tif@1.

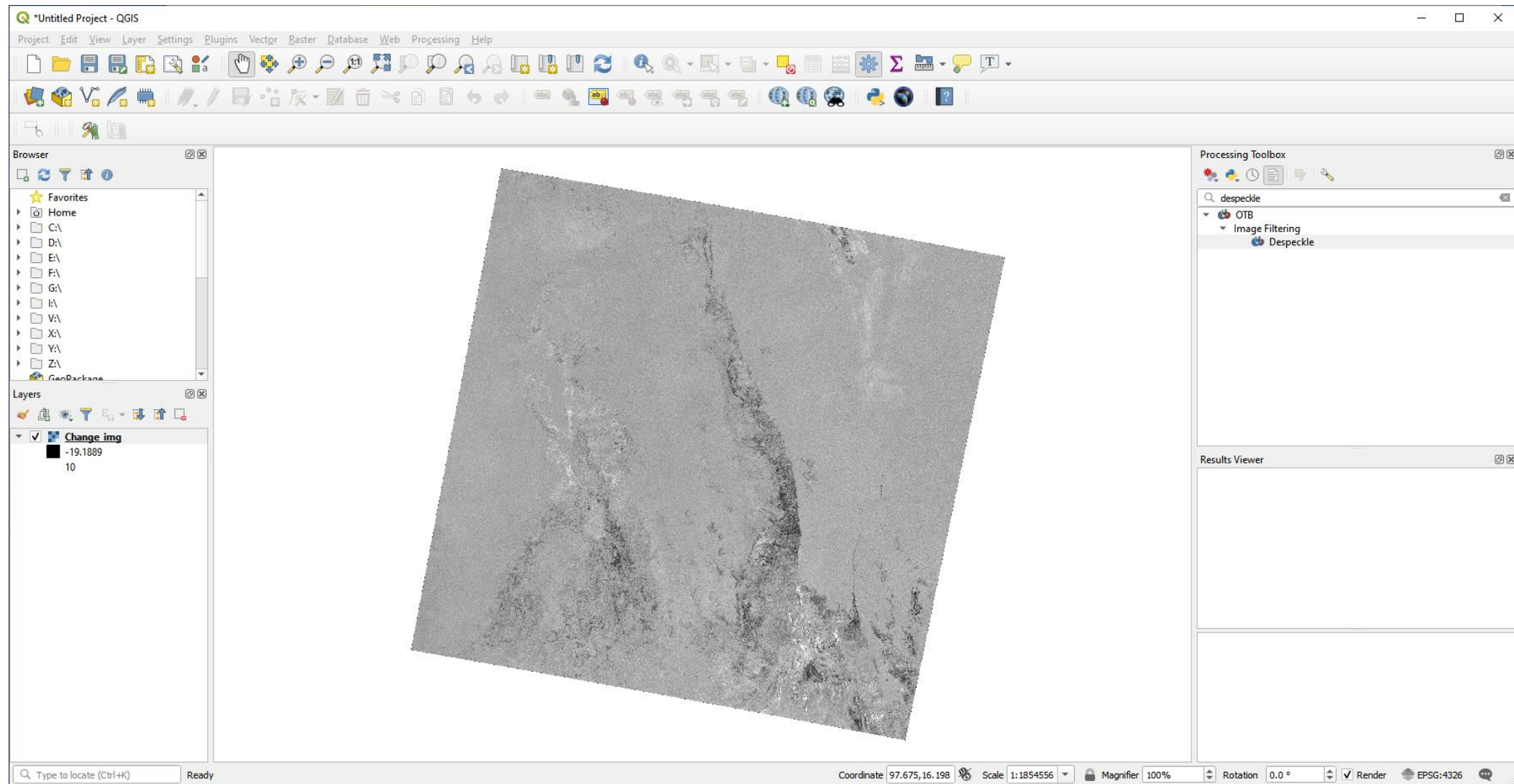
5.4 Click on this icon and select a reference layer



5.5 Click OK

5.6 Click Run

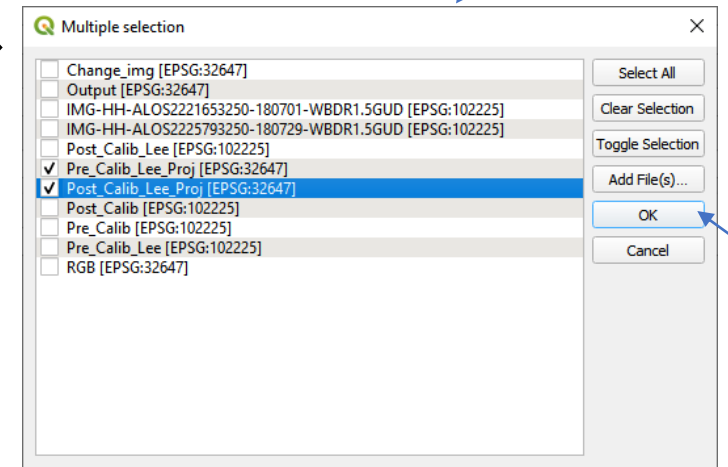
Change Image after raster calculation



6 RGB visualization of post and pre-images

6.1 Goto Raster > Miscellaneous > Build virtual raster

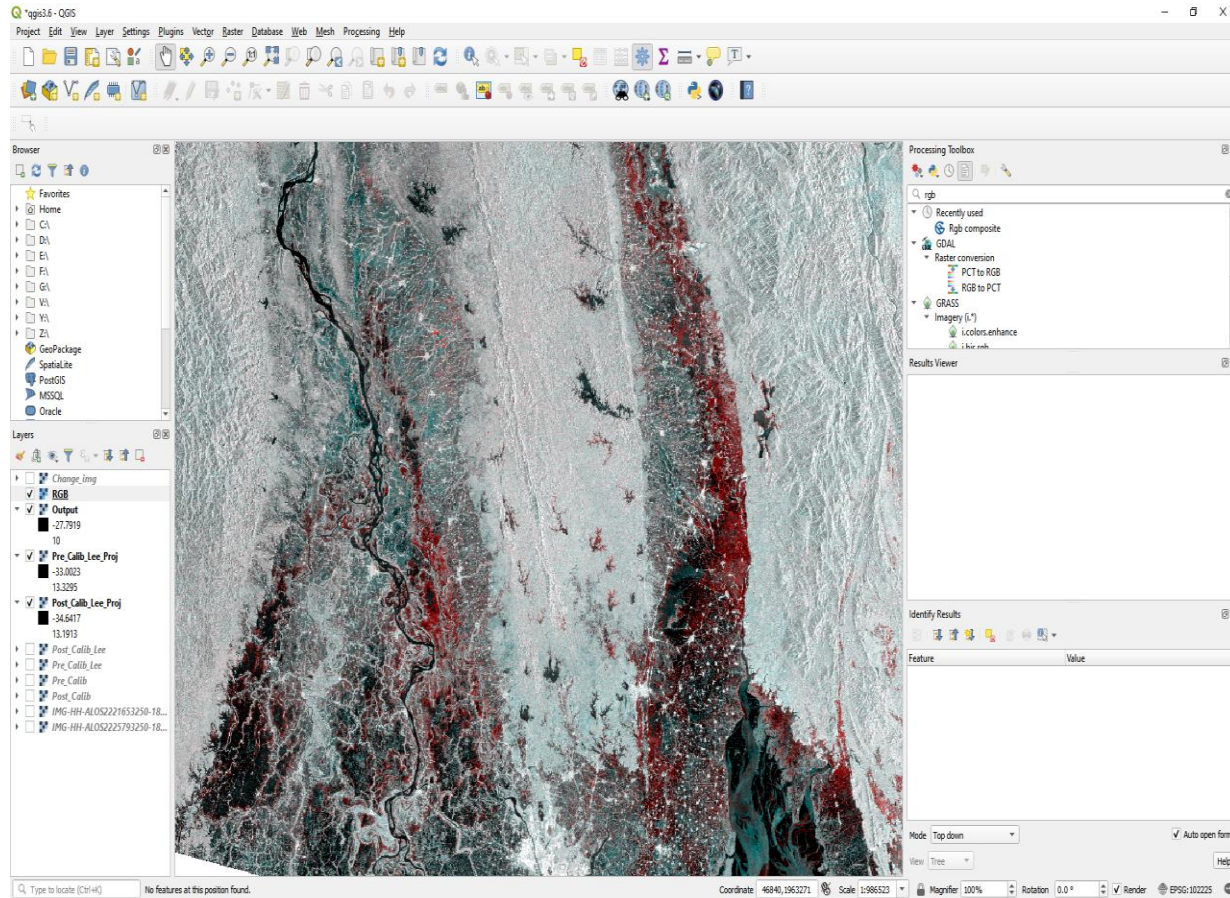
6.2 Click this icon and select the Pre-Processed, pre and post images from this tab



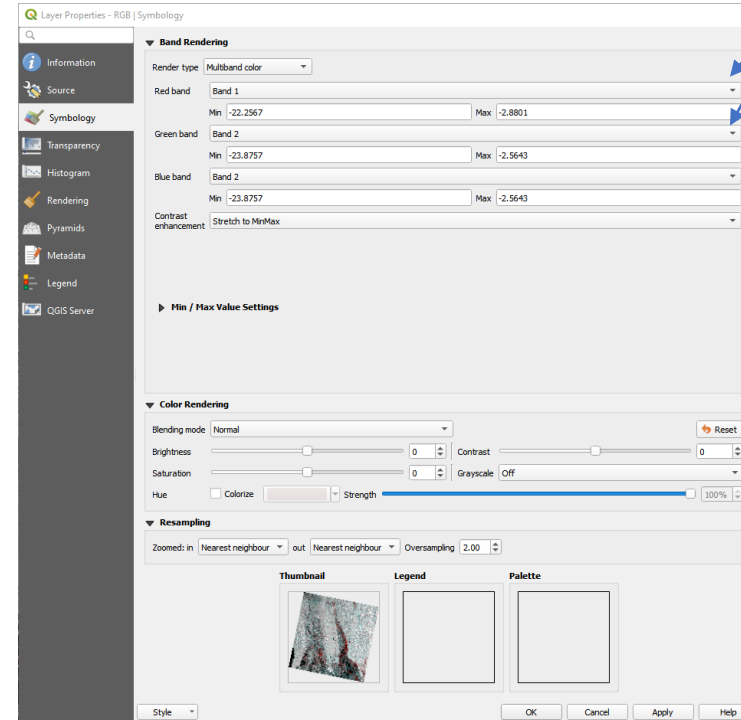
6.3 Click OK

6.4 Click Run.

6.5 Right click on the created virtual band and select **Properties > Symbology**



6.6 Select band 1(pre), band 2(post) from the dropdowns as follows

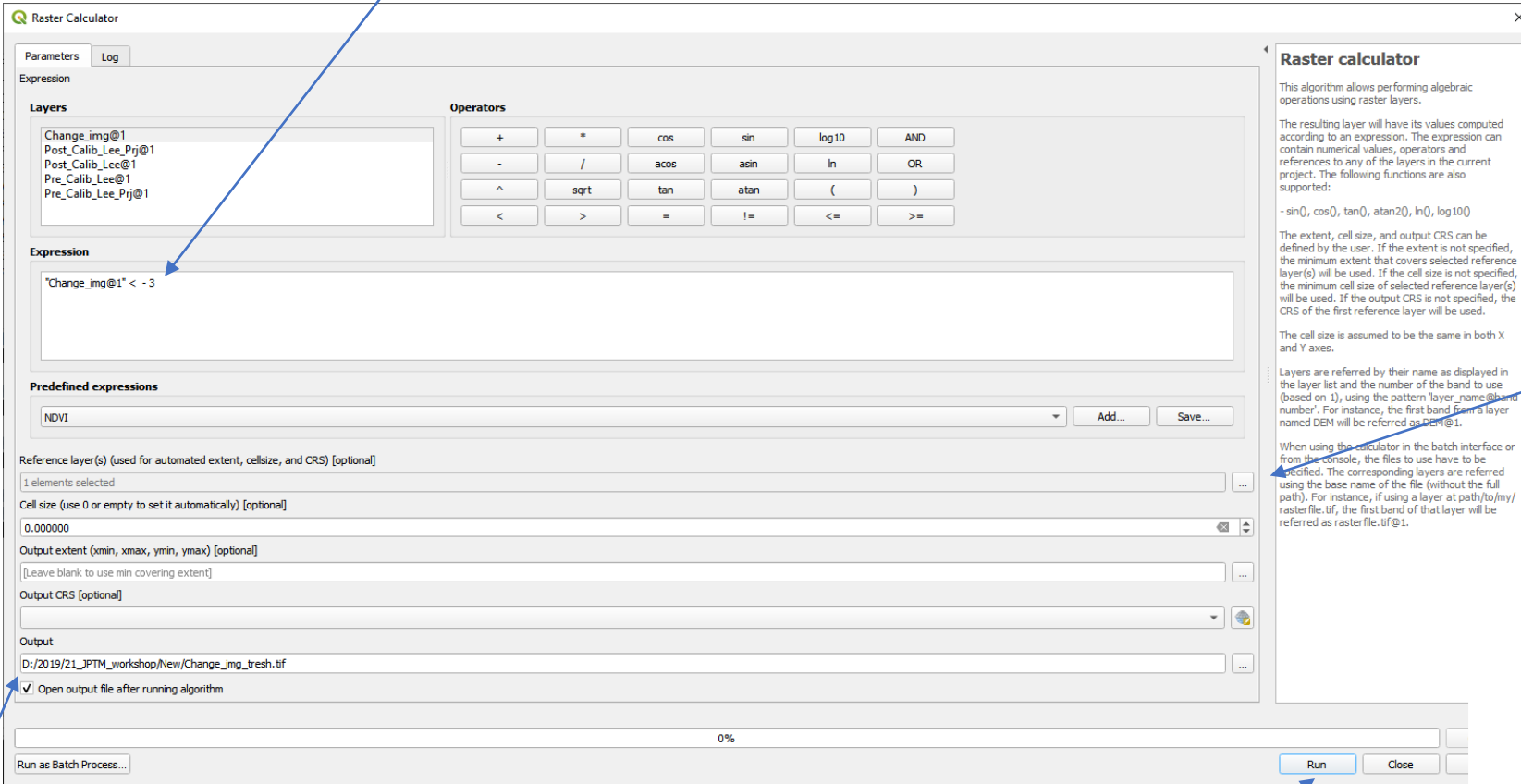


Red Band : Pre-image
Green band: Post-image
Blue Band : Post-image

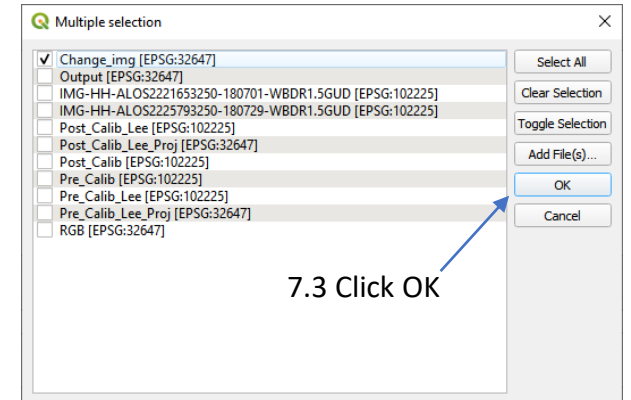
The areas likely to be flooded will appear as **red**, under this particular band combination. Observing change image and this RGB visualization, you can find the radar backscatter value range in the flood region. A threshold value can be selected for delineate the flood extent.

7 thresholding the Pre, Post difference image

7.1 Input Expression as follows (threshold value for detected water selected as -3 here)



7.2 Click on this icon and select a reference layer

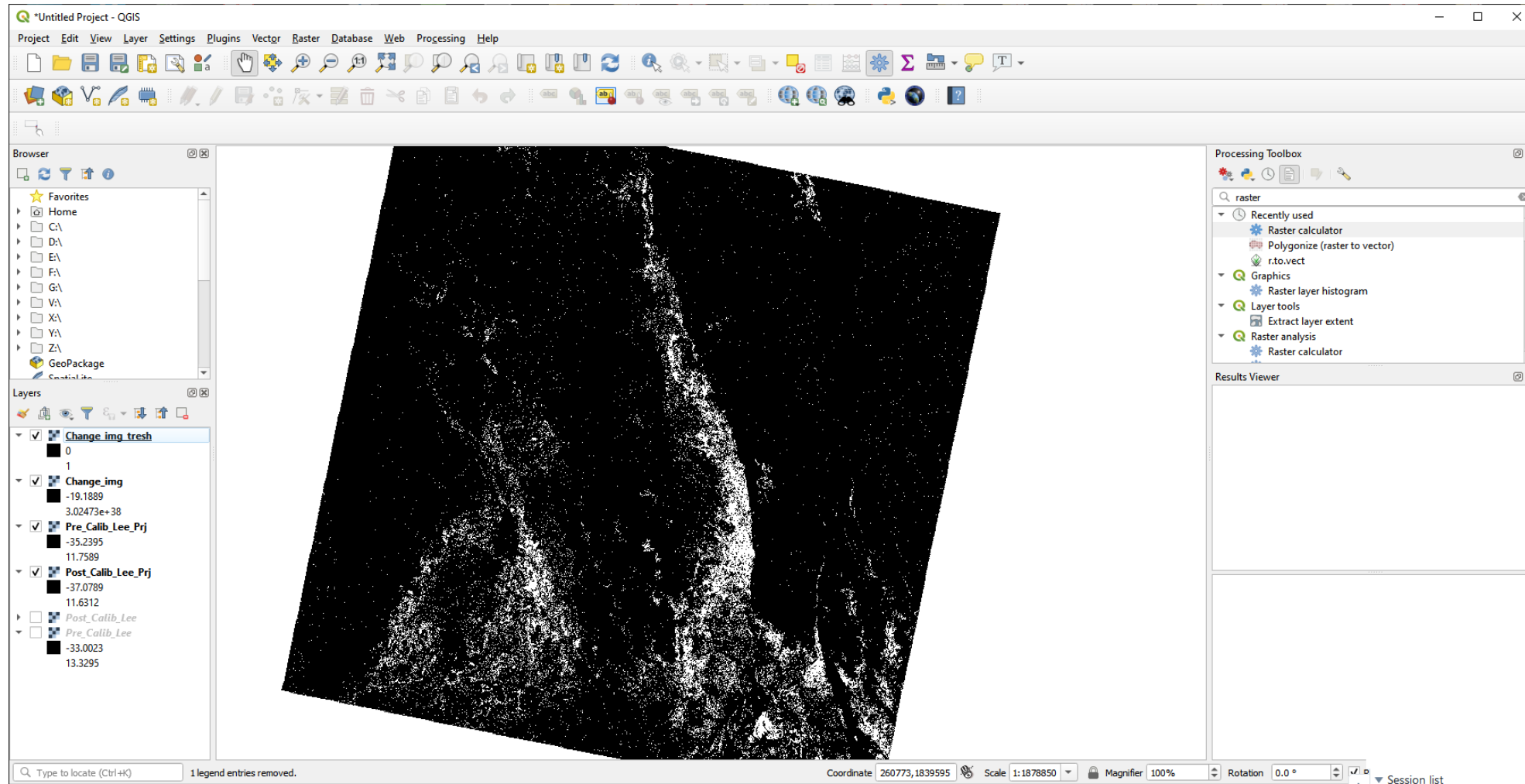


7.3 Click OK

7.4 Browse to the output folder and give it a name and save it as a .tif file

7.5 Click Run

Change Image after thresholding



8 Converting the data type of the threshold image

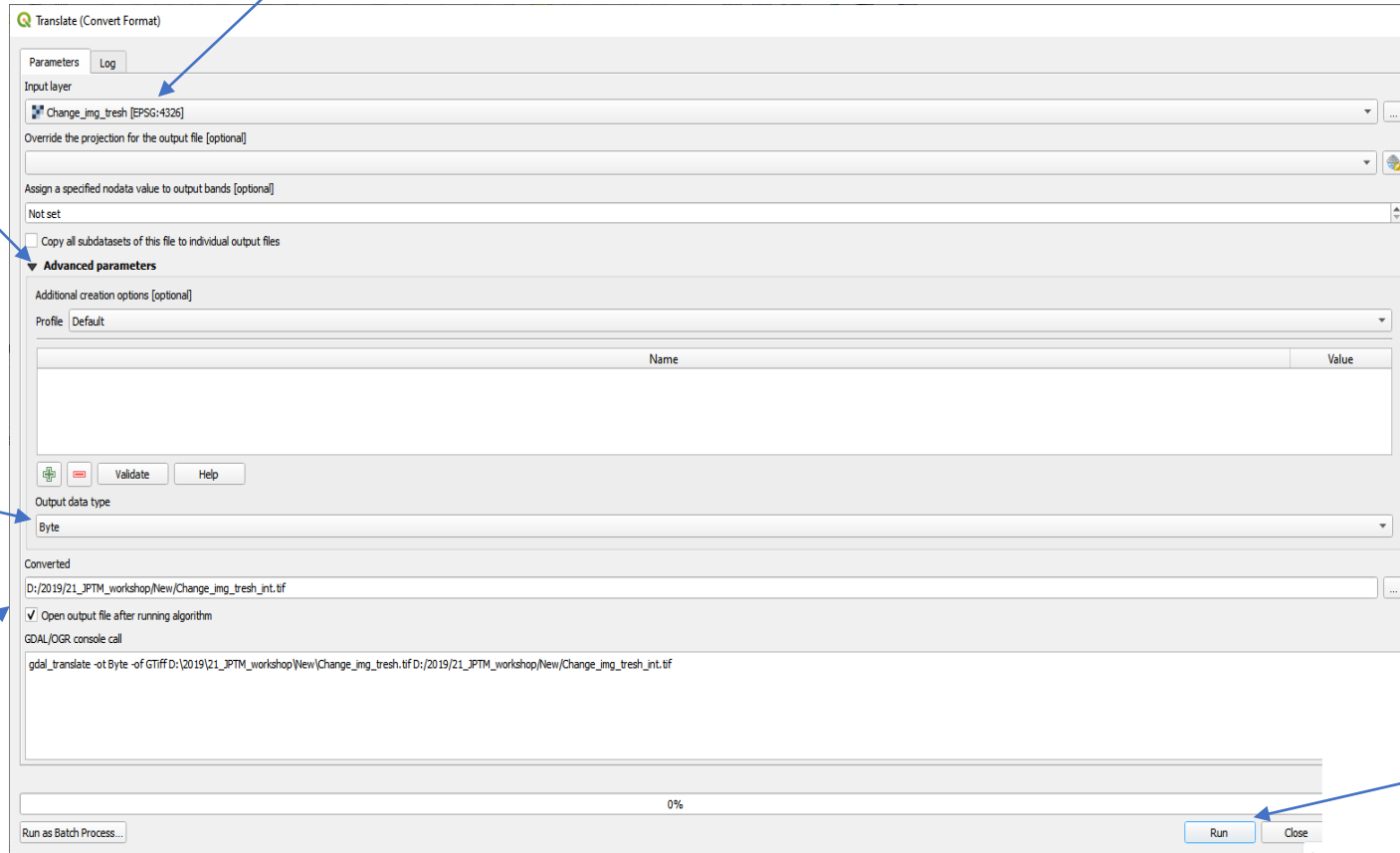
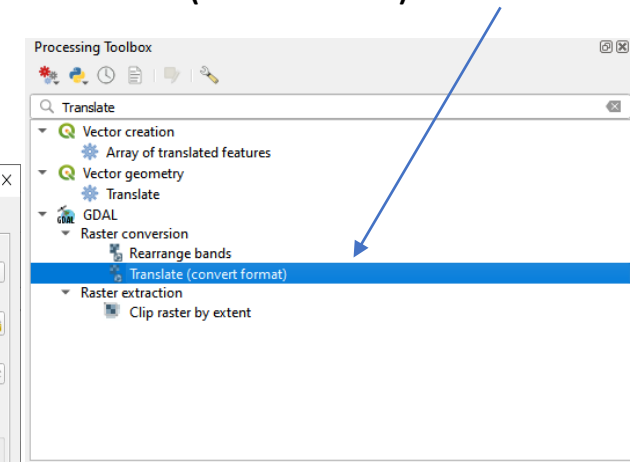
8.1 Type **Translate** in processing toolbox search bar and select the **Translate(convert format)** under **GDAL**

8.2 Select the **threshold image** from the drop down.

8.3 click on advanced parameters

8.4 Change the output datatype as **byte**

8.5 Browse to the output folder and give it a name and save it as a .tif file



9 Application of majority filter to reduce the noise pixels

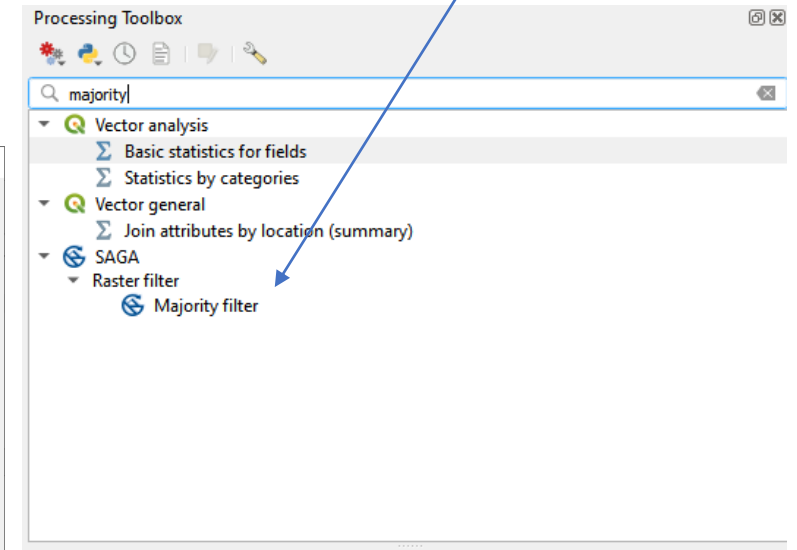
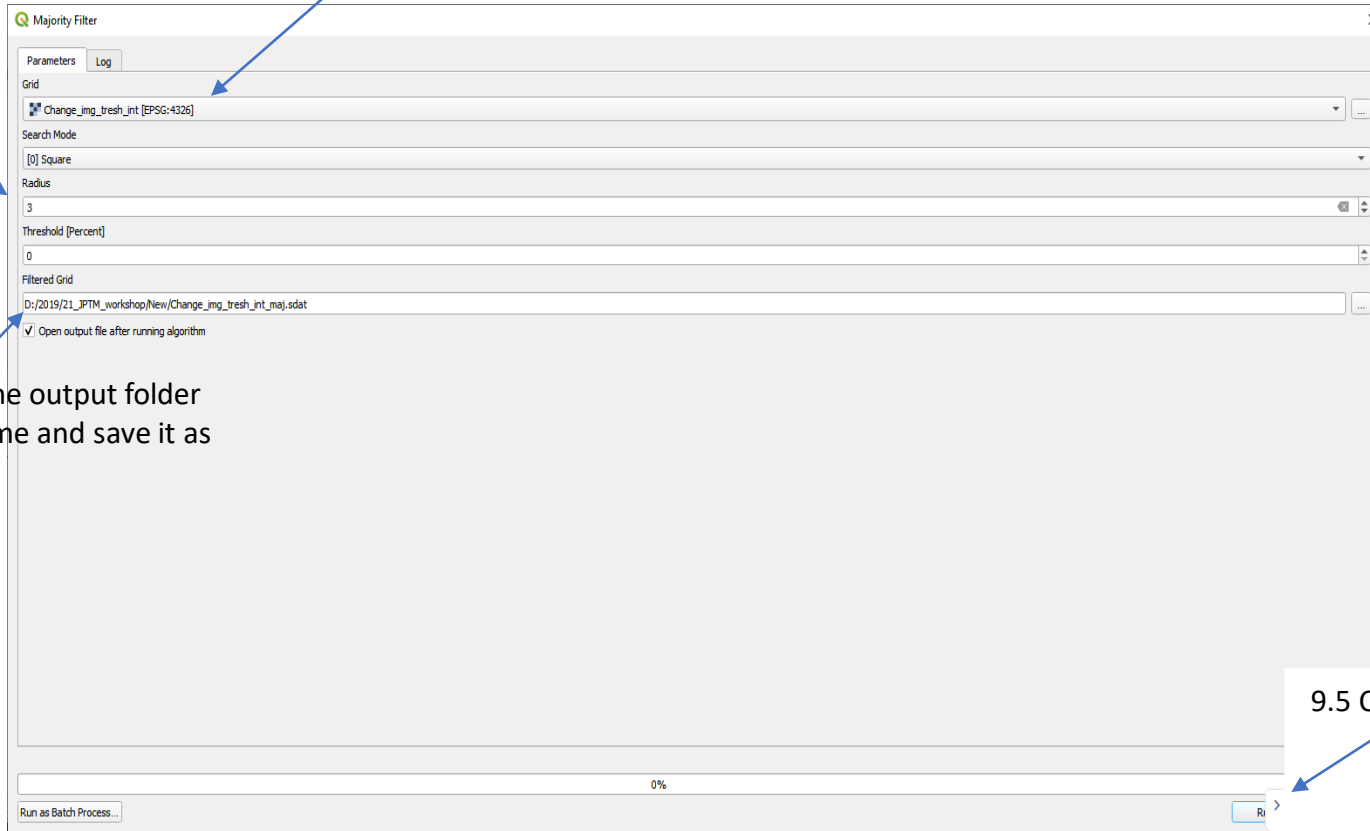
9.1 Type **Majority** in processing toolbox search bar and select the **Majority filter** under **SAGA**

9.2 Select the **threshold image (Byte)** from the drop down.

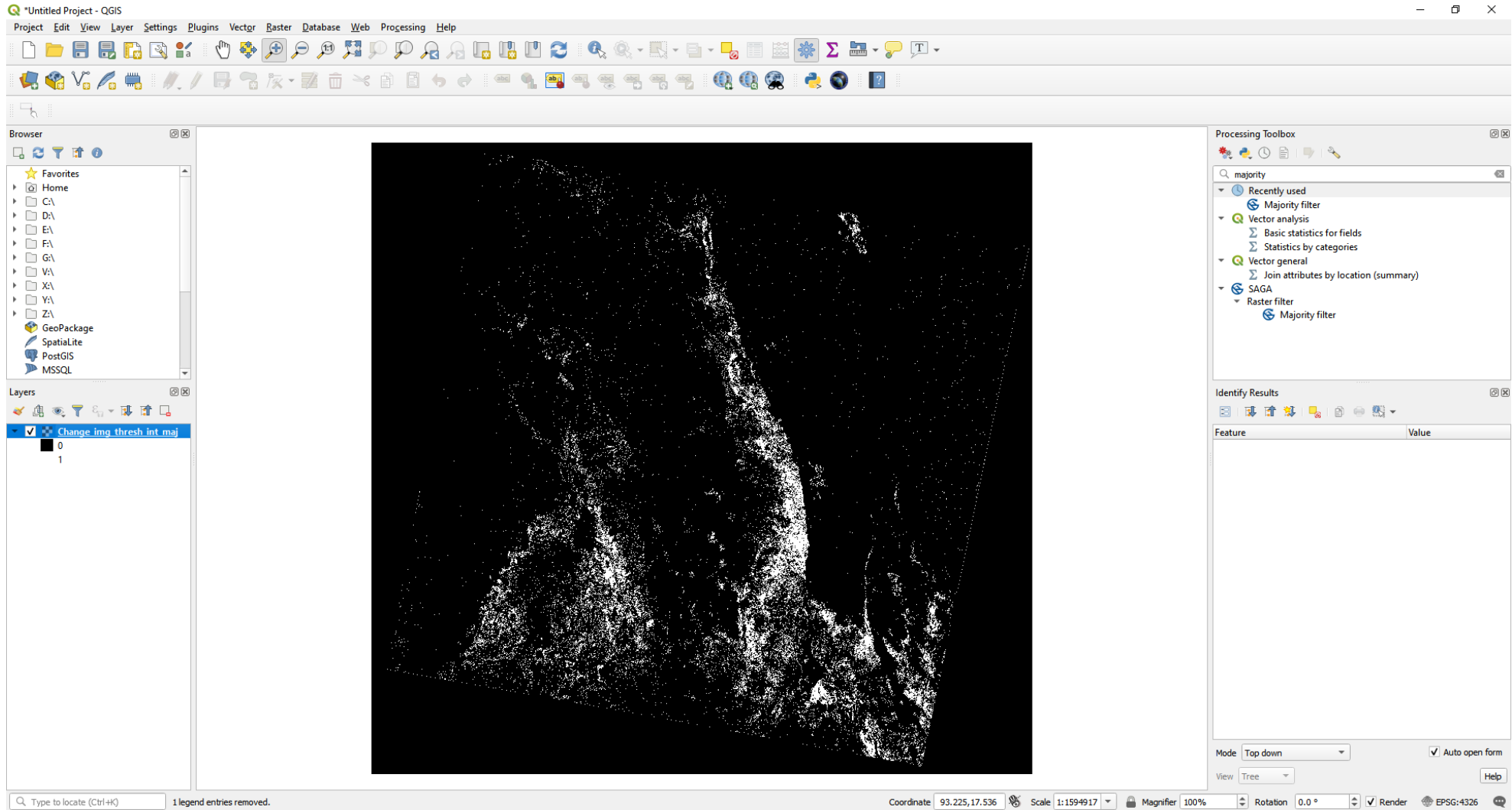
9.3 Input radius as 3 (5*5)

9.4 Browse to the output folder and give it a name and save it as a .sdat file

9.5 Click Run

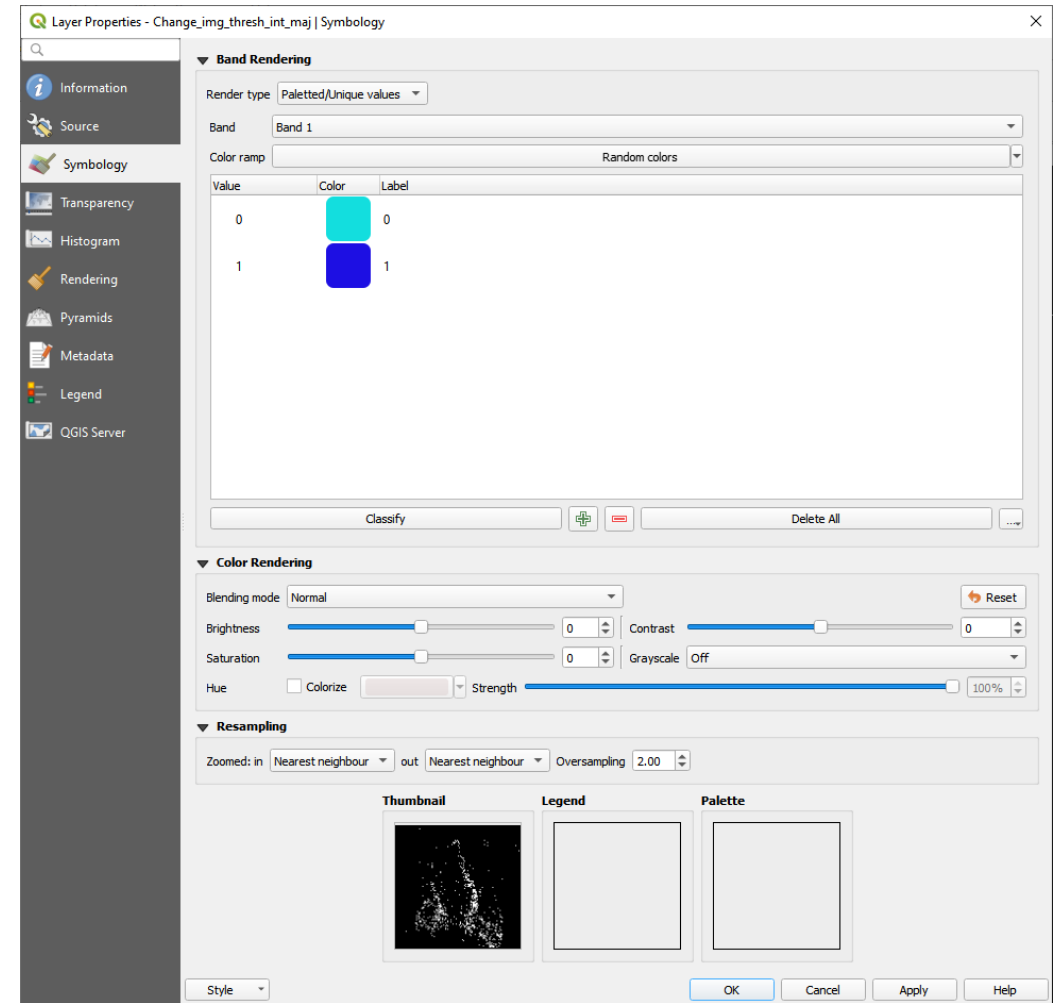
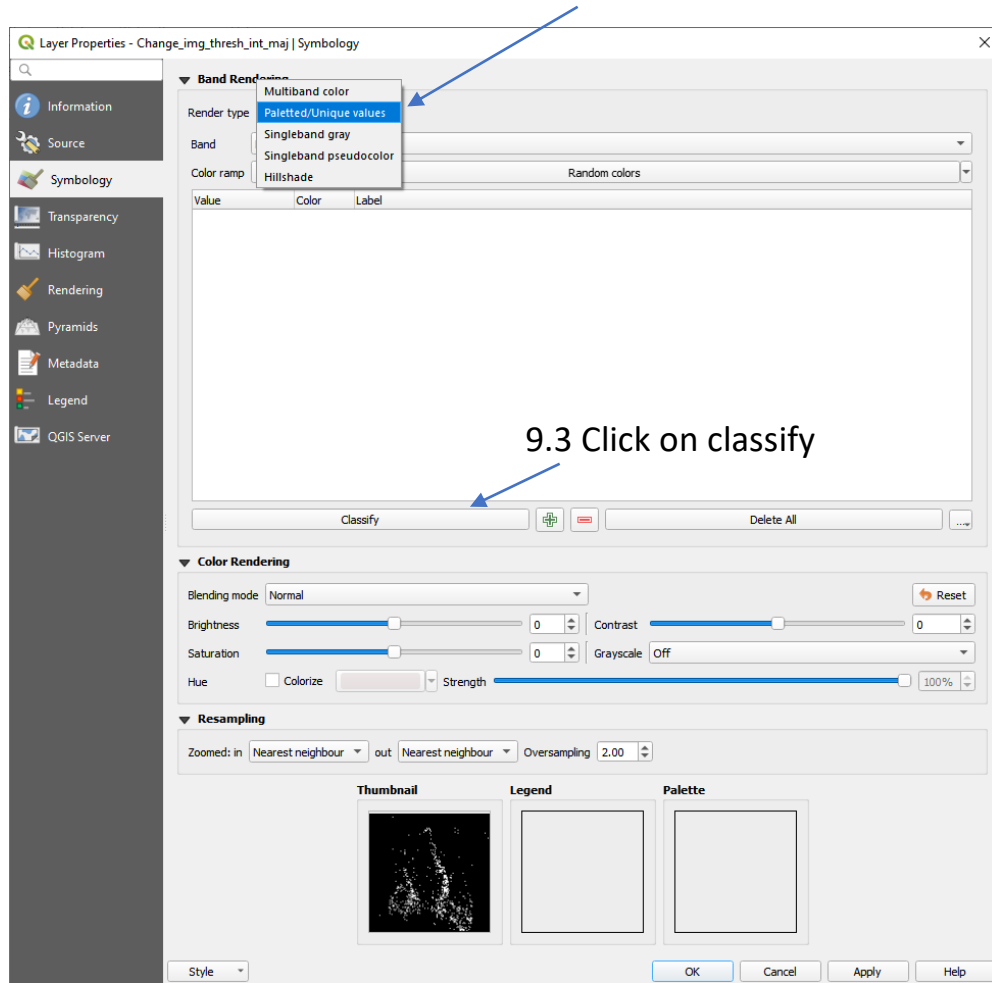


Majority filtered image



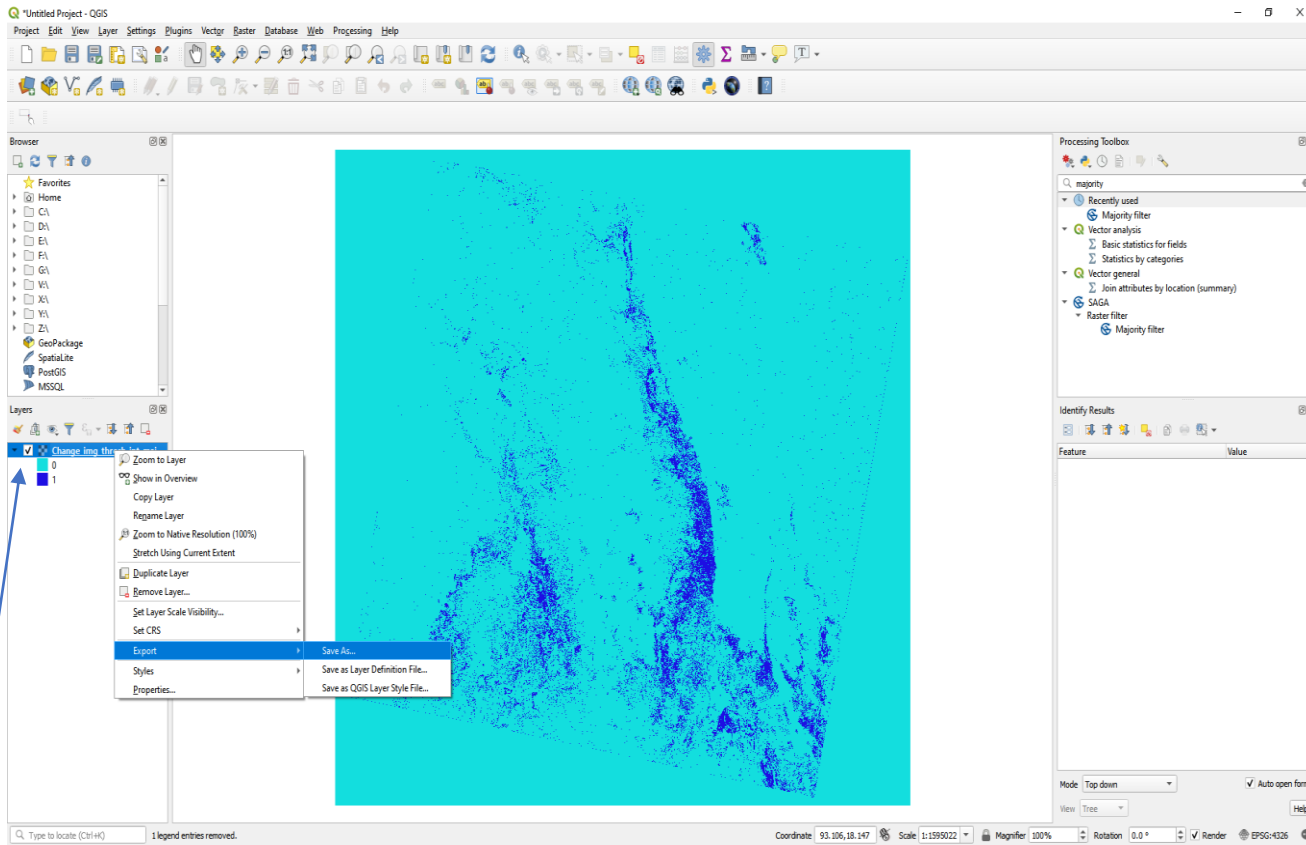
9.6 Right click on the majority filtered image > **Properties**

9.7 select symbology and under render type select **unique values**



9.8 Click OK

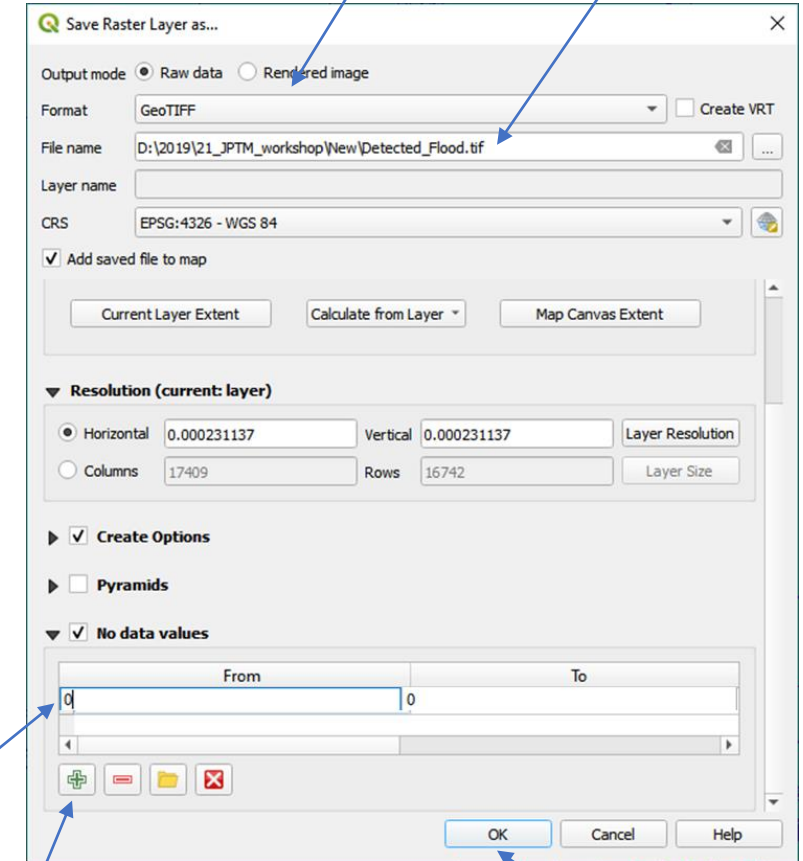
Classified image (water-1, non water-0)



9.9 Right click on the classified image > **Export** > **Save As**

9.10 Set the format as Geotiff

9.11 Browse to the output folder and give it a name and save it as a .tif file

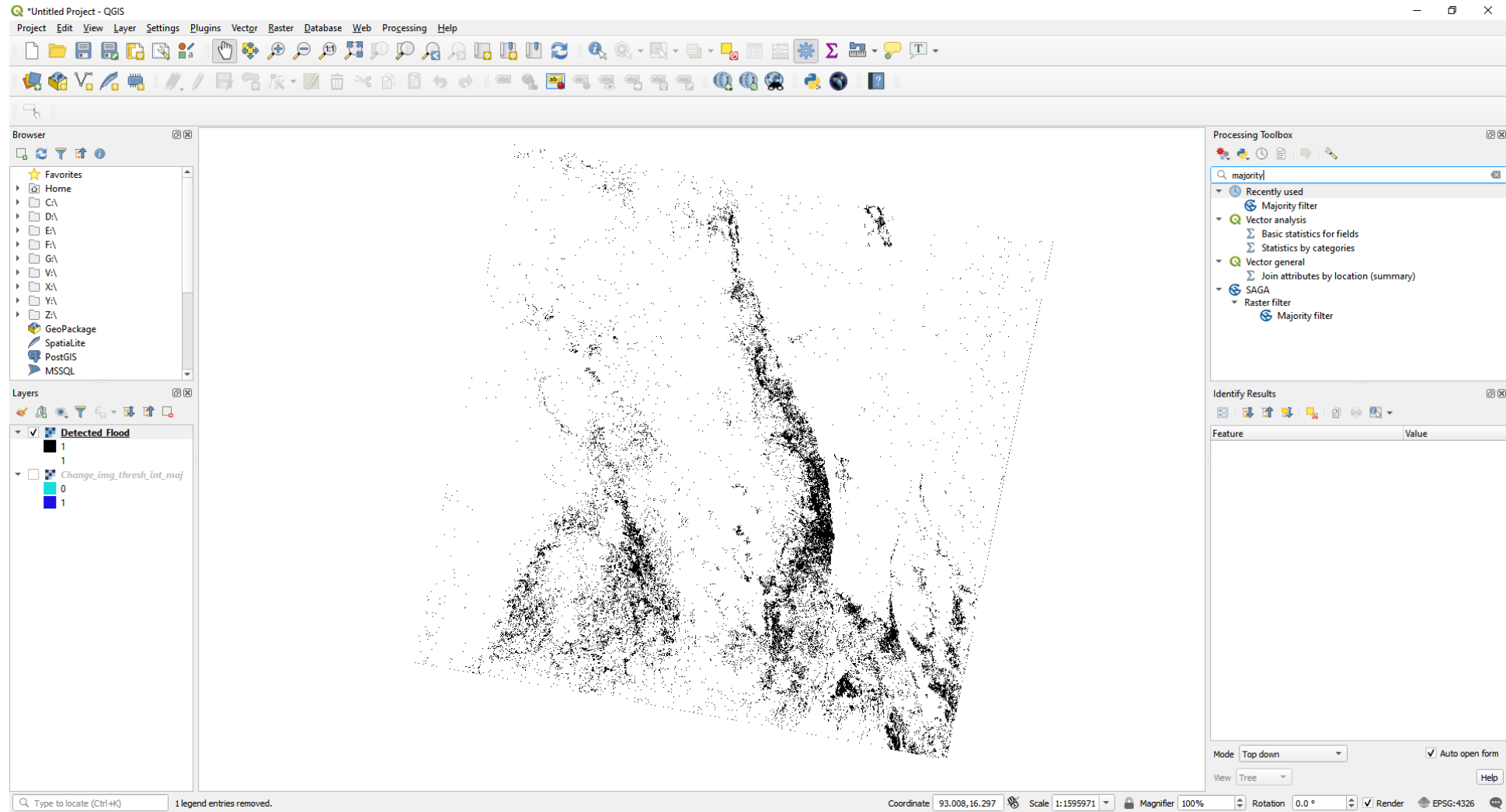


9.13 type 0 here

9.12 Add the no data value as 0 by click on this icon

9.14 click OK

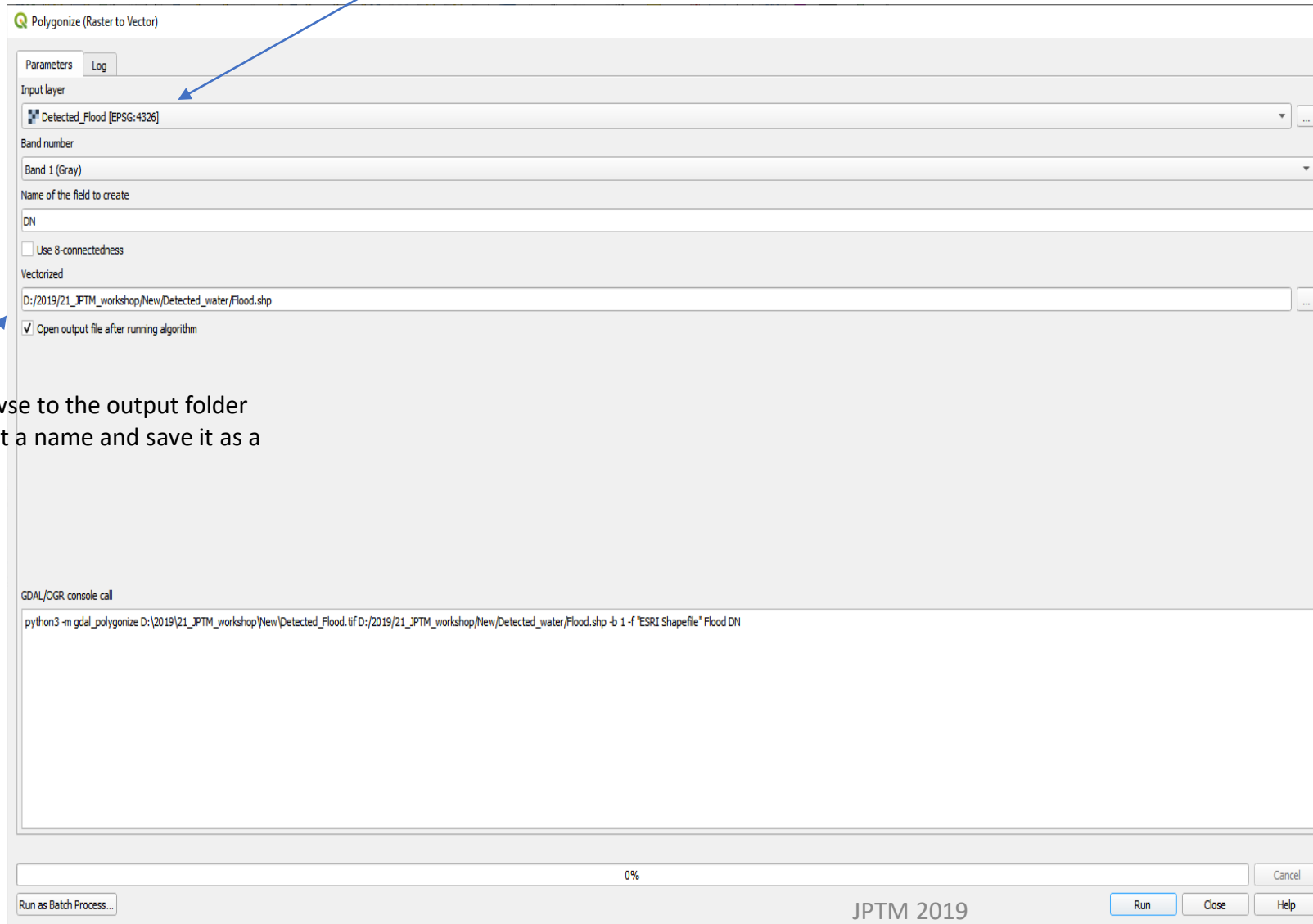
Detected Flood raster image.



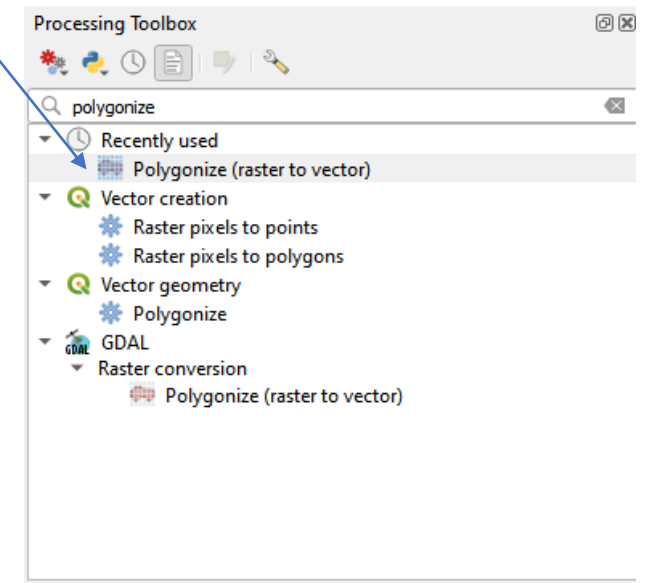
10 Conversion the **Detected Flood** raster file into a vector file

10.1 Type **polygonize** in processing toolbox search bar and select the **Polygonize** under **GDAL**

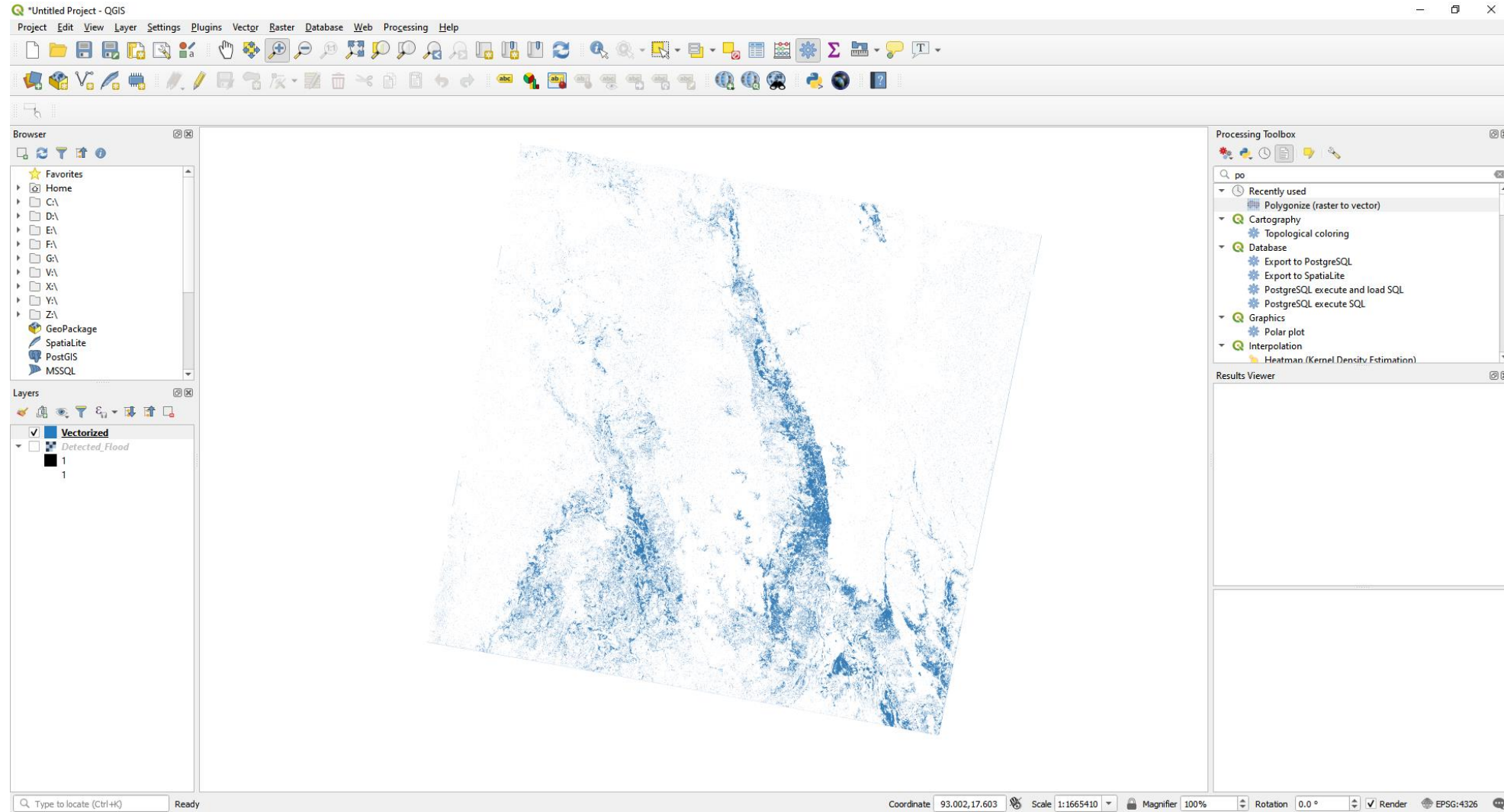
10.2 Select the **Detected flood** raster from the drop down.



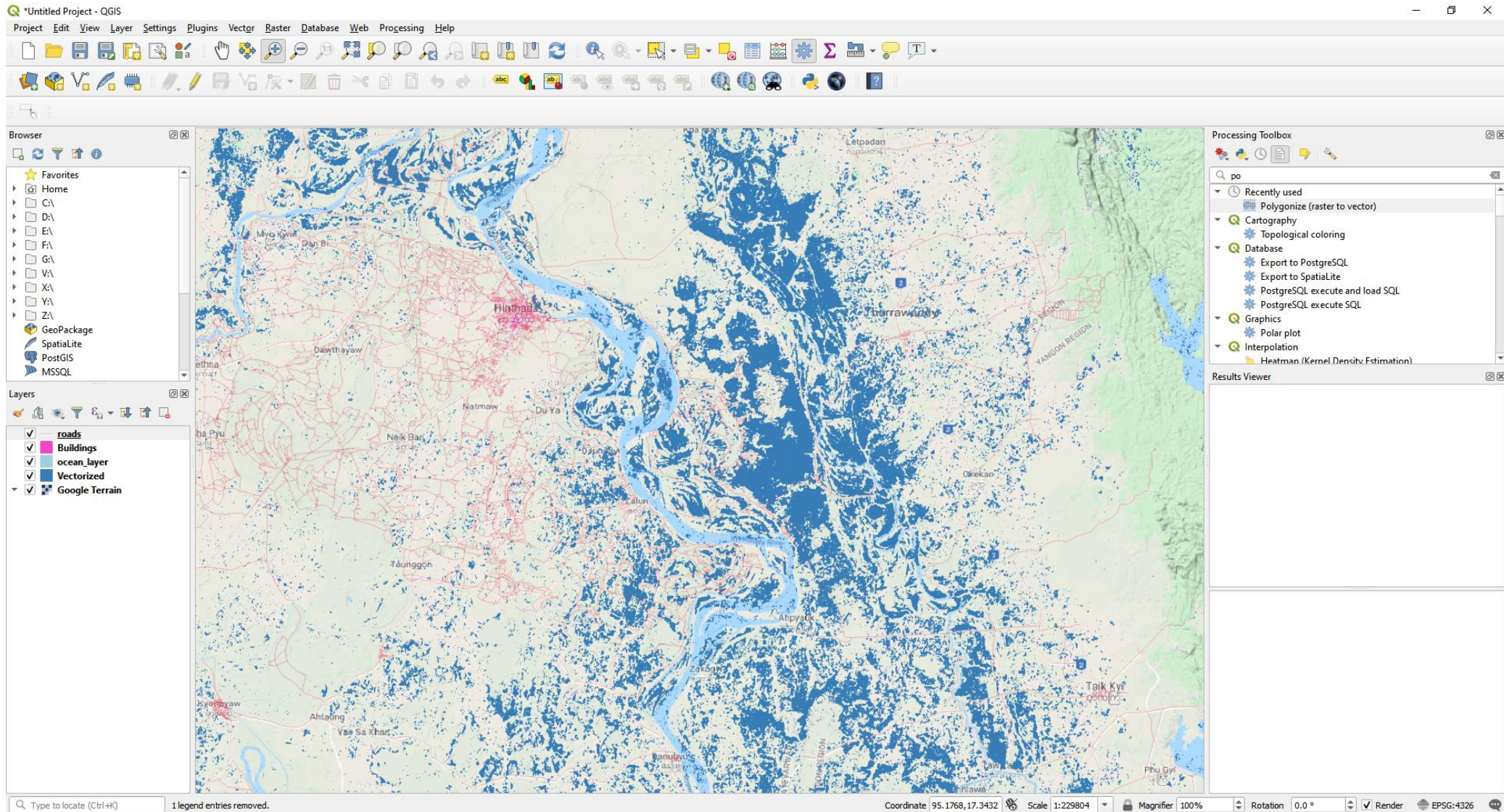
10.3 Browse to the output folder and give it a name and save it as a .shp file



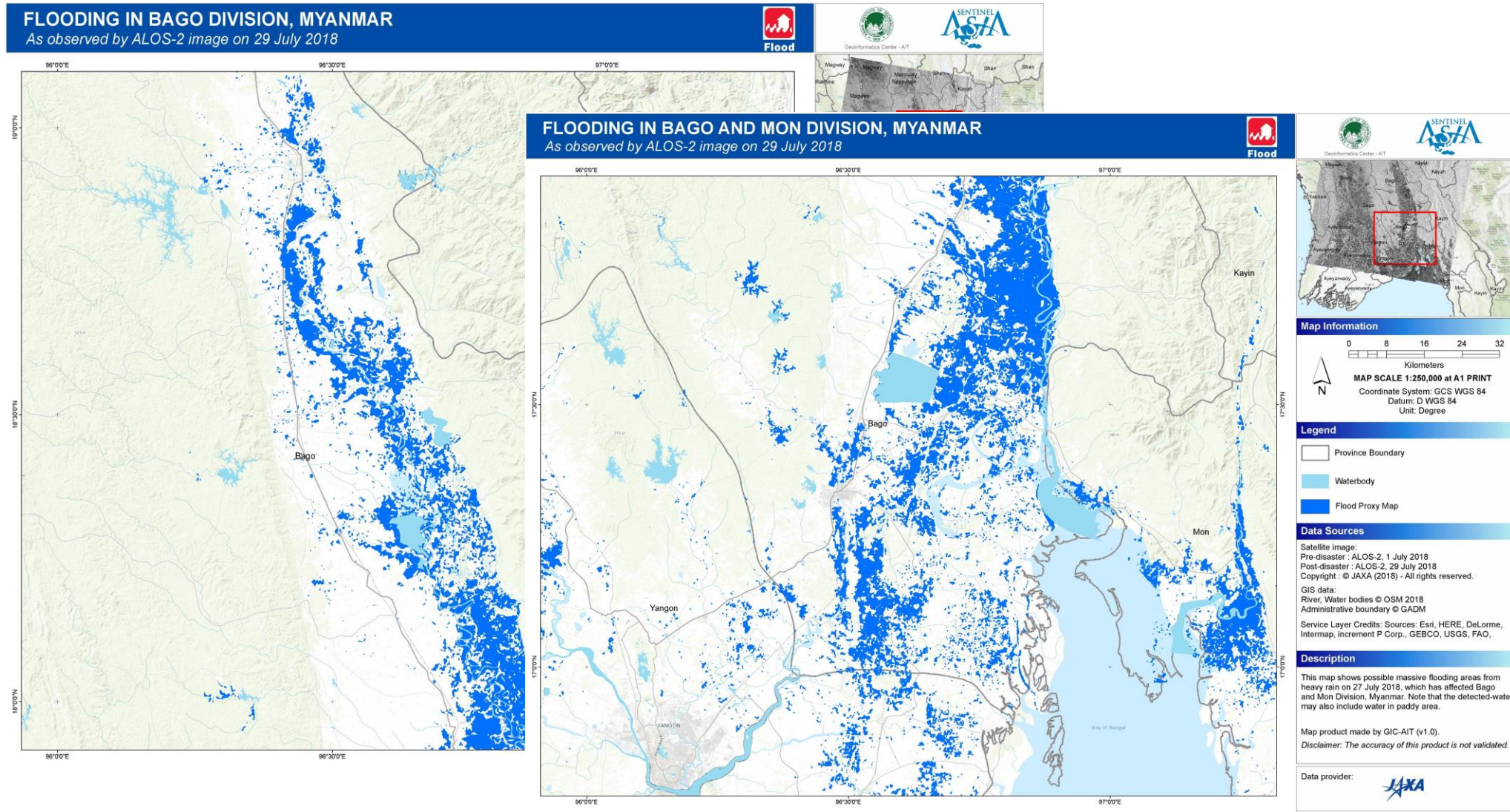
Detected Flood in Vector format



To make Value Added Product more informative, you can combine OSM data with these processed product.



Value added products after combined with more information



Useful links:

OSM Data Download : <https://download.geofabrik.de/>

Marine region shape file Download : <http://www.marineregions.org/gazetteer.php?p=details&id=1904>

Thank You!