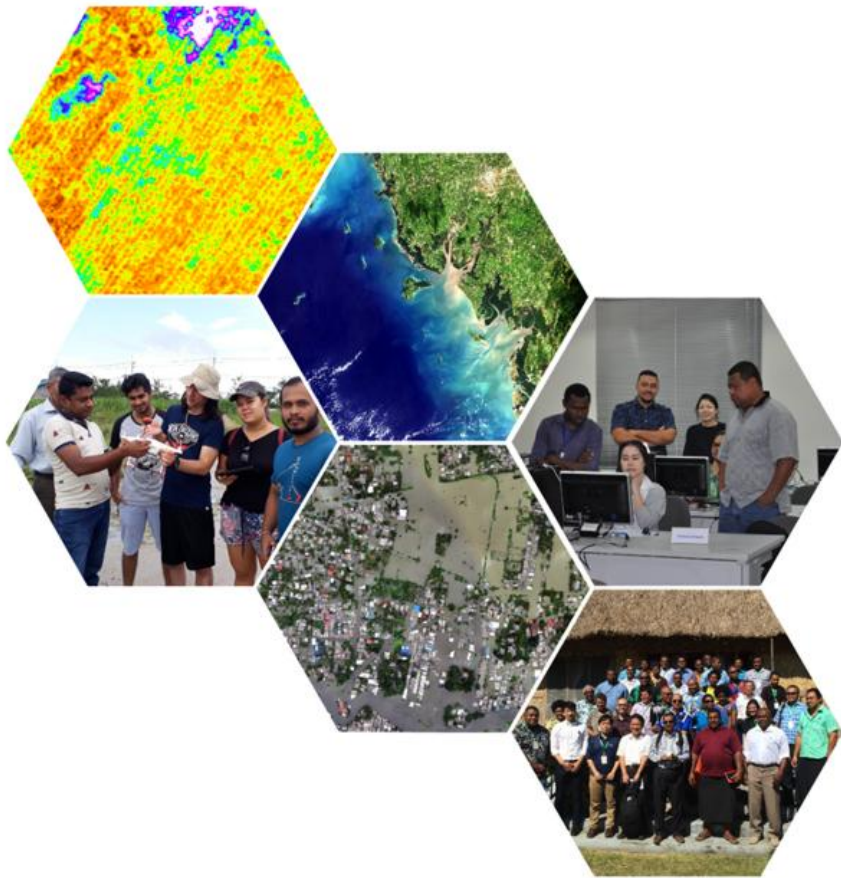


Flood Mapping using ALOS-2: Backscatter Thresholding



Geoinformatics Center - AIT

Overview

Flood in Western, Nepal on 30 June 2025

DETECTED FLOOD WATER IN KANCHANPUR DISTRICT

NEPAL

As observed by ALOS-2 images on 5 July 2025



20 Km²
FLOOD AREA



This map shows the detected flood water areas in Kanchanpur district, Sudurpashchim Province, Nepal, on 30 June, 2025, due to heavy rain.



0

NUMBER OF DEATHS



1,622

AFFECTED HOUSEHOLDS

Source: The Rising Nepal, 8/7/2025

- Detected Flood Water
- Building
- Province Boundary
- District Boundary
- Municipality Boundary
- Waterbody
- Waterway
- Road

Satellite Image:

Pre-disaster : ALOS-2 PALSAR-2,
1 February 2025

Post-disaster : ALOS-2 PALSAR-2,
5 July 2025

Copyright: © JAXA (2025) -
All rights reserved.

GIS Data:

Building and Road © OSM (2025)
Administrative Boundary © GADM (2025)

Map product made by GIC-AIT (v1.0).

Disclaimer: The accuracy of this product
is not validated.

Sentinel Asia activation:

- Occurrence Date (UTC): 30 June, 2025
- SA activation Date(UTC): 01 July, 2025
- Requester: Department of Hydrology and Meteorology (DHM), Ministry of Energy, Water Resources and Irrigation

Overview

Objective

The objective of this exercise is to generate a flood map from ALOS-2 SAR data by performing a complete processing workflow consisting of data pre-processing, flood classification using a threshold-based binary method, and post-processing refinement techniques.

The final product aims to produce accurate flood boundary delineation for emergency response purposes.

Overview

Data and Software

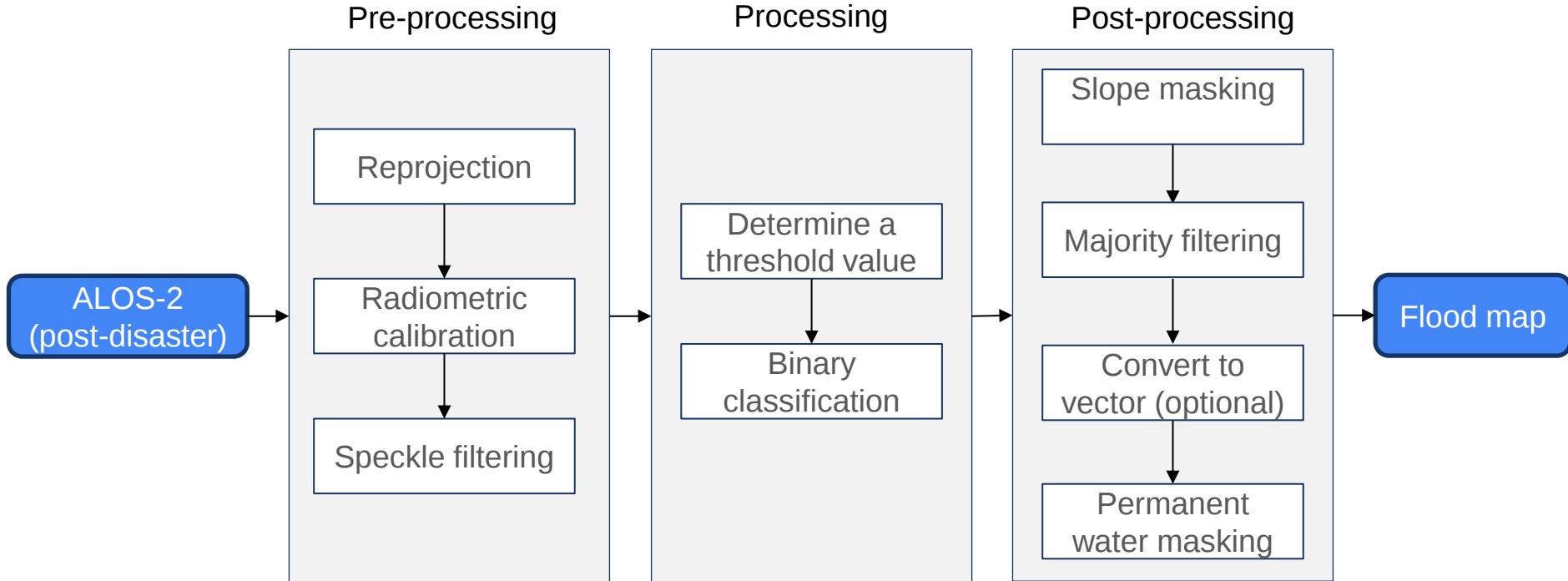
In this exercise, we will use QGIS software.

The following data are available:

- **ALOS-2 Level 2.1**
 - Geometrically corrected (orthorectified) data using the digital elevation data from Level 1.1.
 - Observation mode: Stripmap, Dual Polarization (HH and HV)
 - Spatial resolution: 6.25m, Data format: GeoTIFF
 - Date: 05 July 2025 (observe), 1 February 2025 (archive)
- **Ancillary data**
 - Copernicus 30m DEM
 - OSM permanent water data shapefile

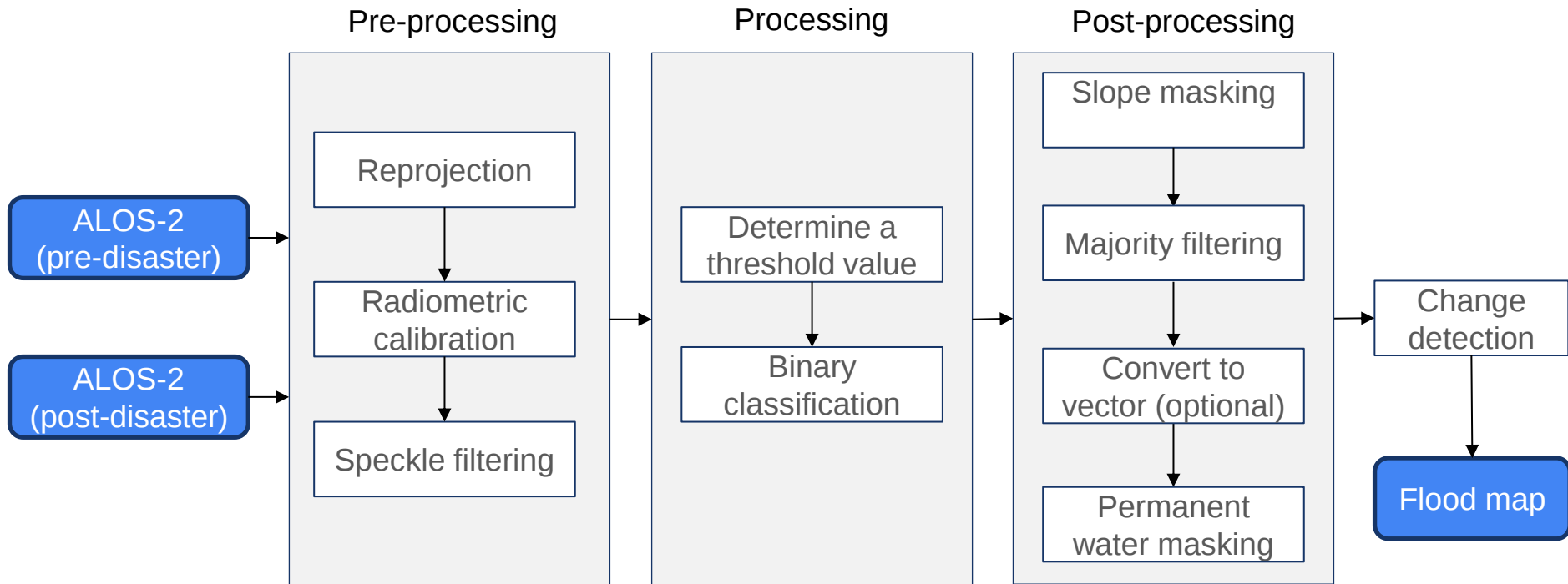
Methodology

Flood mapping using ALOS-2 data (single post-disaster data)



Methodology

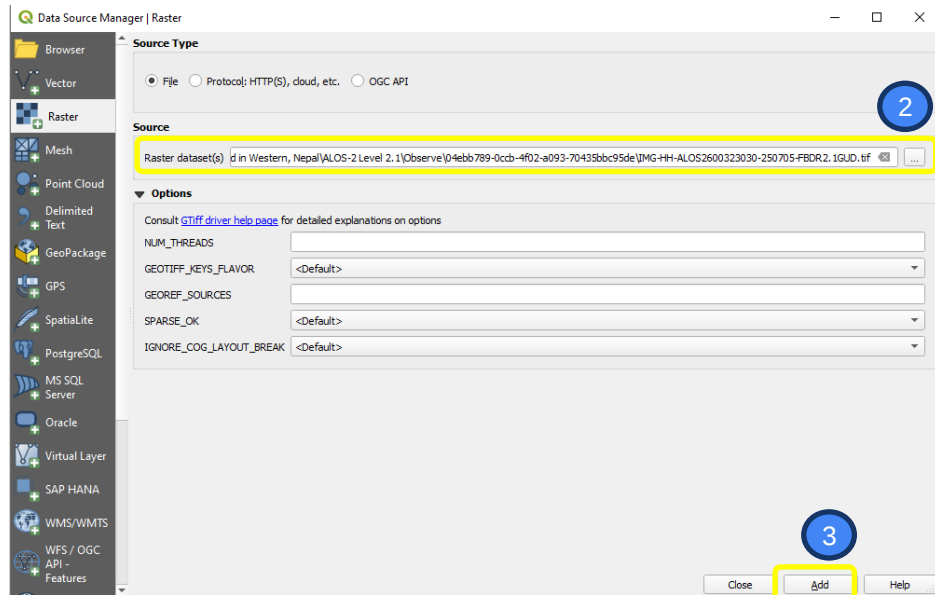
Flood mapping using ALOS-2 data (pre- and post-disaster data)



Data Pre-processing

Follow Along: Open ALOS-2 data (5 July 2025)

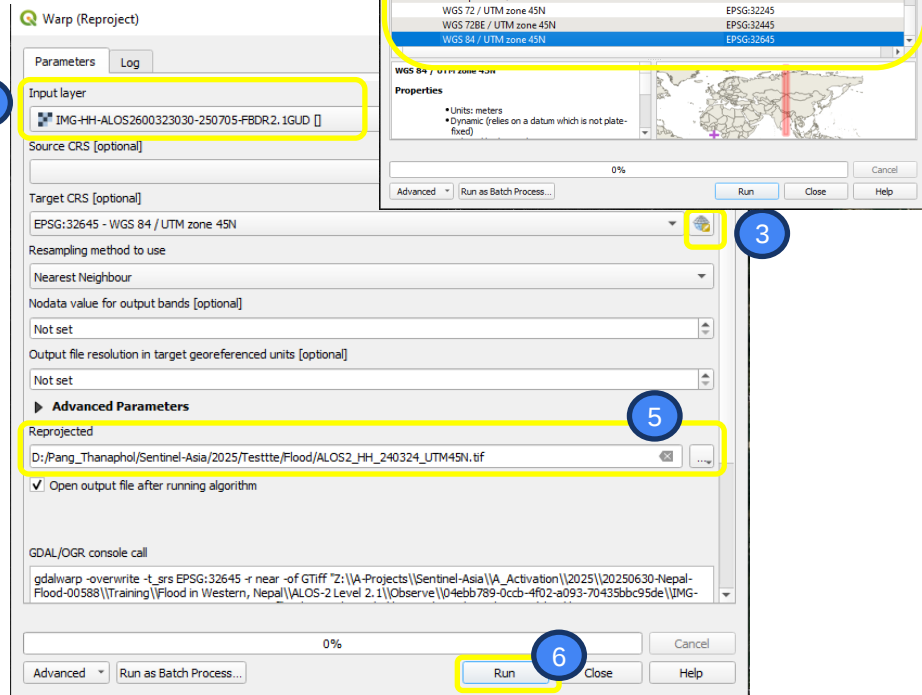
1. In the Menu Bar, click on **Layer → Add Layer → Add Raster Layer**.
2. In Data Source, click on the **Browse** button  and navigate to the file **IMG-HH-ALOS2600323030-250705-FBDR2.1GUD.tif** in the ALOS-2 L2.1 archive data folder.
3. With this file selected, click **Add**, then **Close**.
The data you specified will now load.



Data Pre-processing

Follow Along: Reprojection

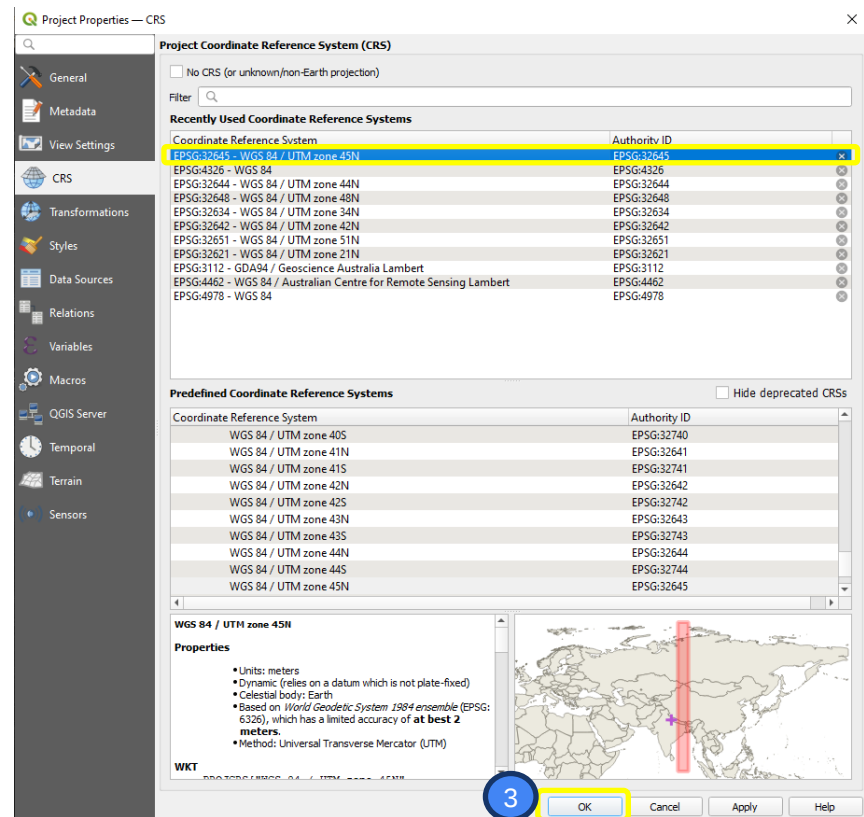
1. In the Menu Bar, click on **Raster** → **Projection** → **Warp (Reproject)**.
2. In the Input Layer, select **IMG-HH-ALOS2600323030-250705-FBDR2.1GUA**
3. In the Target CRS (optional), click 
4. Select Predefined CRS, then **EPSG:32645 – WGS84 / UTM Zone 45N**.
5. Save the result to **ALOS2_HH_250705_UTM45N.tif**
6. Click **Run**.



Data Pre-processing

Follow Along: Change the project CRS

1. In the Menu Bar, click **Project** → **Properties**.
2. Select **EPSG:32645 – WGS84 / UTM Zone 45N**
3. Click **OK**.



Data Pre-processing

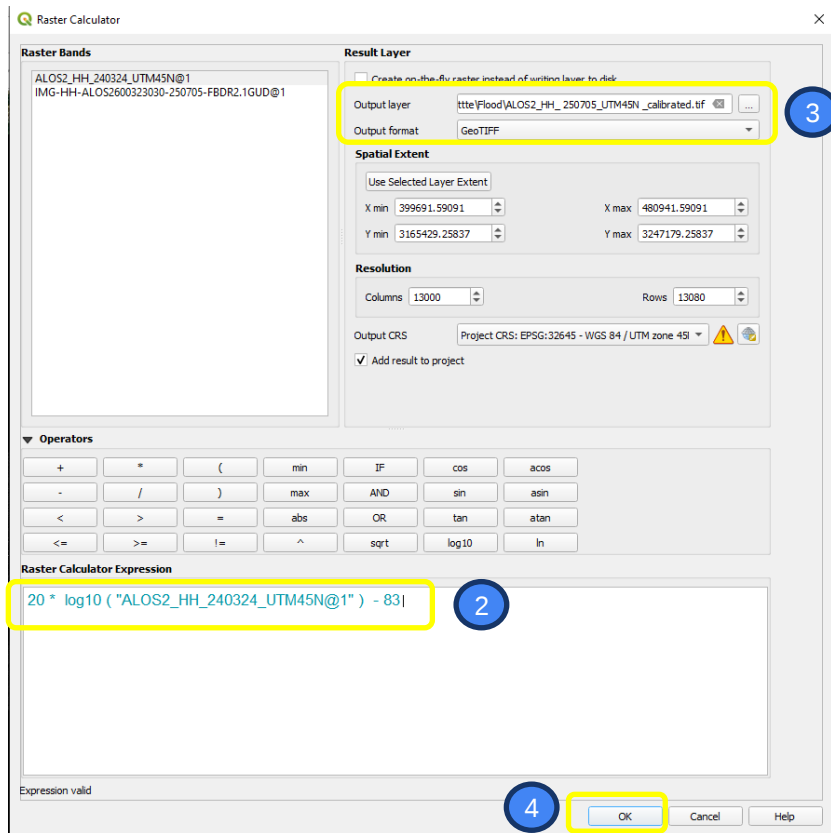
Follow Along: Radiometric calibration

Digital number in the ALOS-2 JAXA product is converted to backscattering coefficient (sigma naught, sigma zero) using the following equations:

$$\sigma_{016}^0 = 10 \cdot \log_{10} \left(DN^2 \right) + CF_1$$

(for L1.5, L2.1)

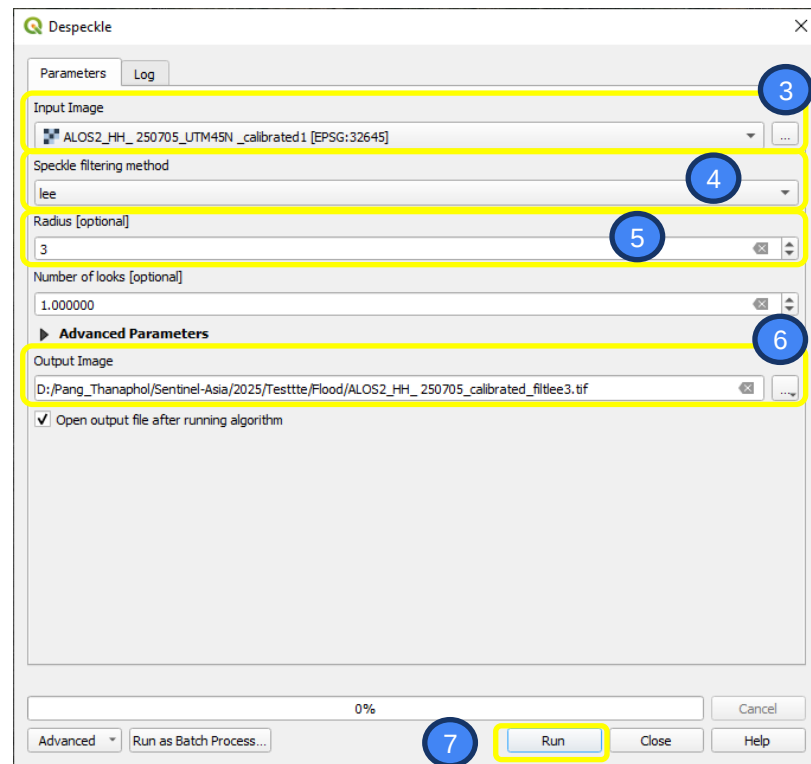
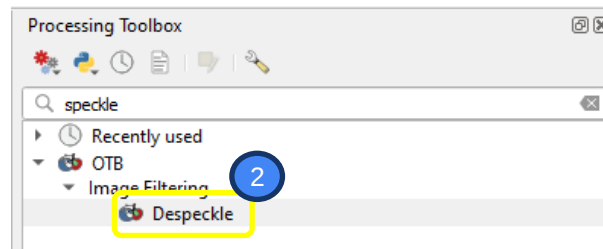
1. In the Menu Bar, click on **Raster** → **Raster Calculator**.
2. In the Raster Calculation Expression write:
`20 * log10 ( " ALOS2_HH_250705_UTM45N@1" ) - 83`
3. Save the result to **ALOS2_HH_250705_UTM45N_calibrated.tif**
4. Click **OK**.



Data Pre-processing

Follow Along: Speckle filtering

1. In the Menu Bar, click [Processing](#) → [Toolbox](#).
2. Search for [OTB](#) → [Image filtering](#) → [Despeckle](#)
3. In the Input Layer, select [ALOS2_HH_250705_UTM45N_calibrated.tif](#)
4. In the Speckle filtering method, select [lee](#).
5. In the Radius (optional), write [3](#). The unit of radius is pixel.
6. Save the result to [ALOS2_HH_250705_calibrated_filtlee3.tif](#)
7. Click [Run](#).



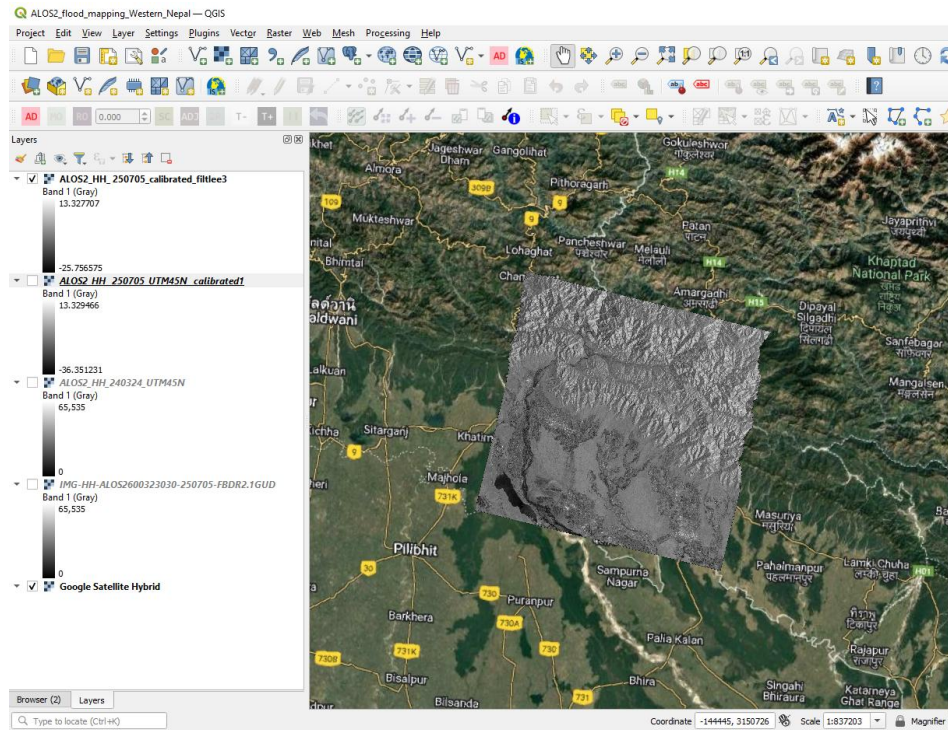
Data Pre-processing

Follow Along: Save your work!

You can open the calibrated image and observe the object on the image. Can you visually identify any inundated areas here?

Now would be a good time to save your work.

1. In the Menu Bar, click on **Project → Save As**
2. Save the map in the working folder:
`ALOS2_flood_mapping_Western_Nepal.qgs`

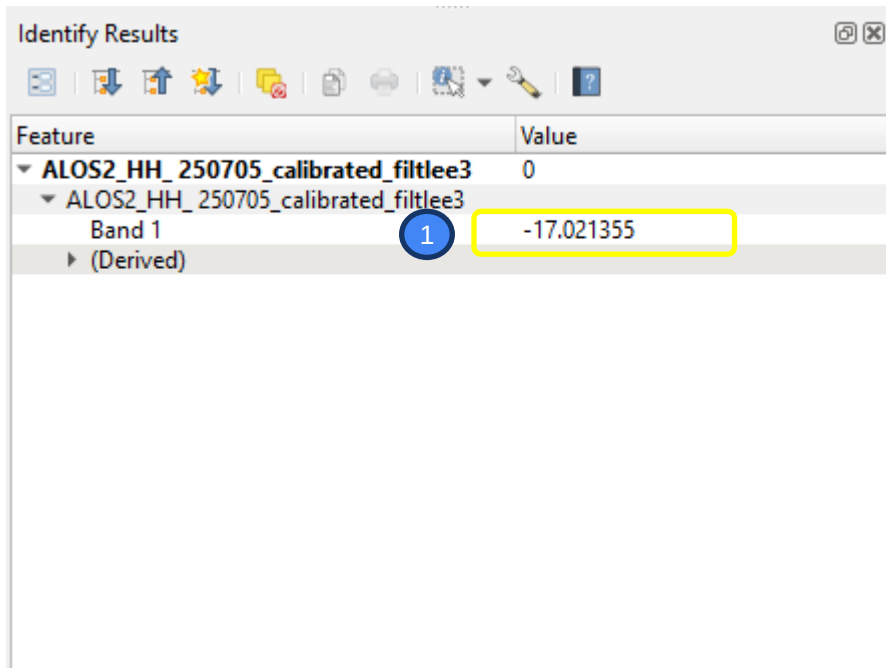


Determine a Threshold Value

Follow Along: (Option 1) Manual visual observation

You can determine threshold values by a manual visual observation. Flooded areas often appear as dark regions in SAR images because open water surfaces cause specular reflection, resulting in lower backscatter returns. Examine the image and incrementally adjust the threshold value while seeking a value that best separates flooded and non-flooded areas.

1. Use [Identify Features](#)  tool to inspect the backscatter value. Click on a specific pixel on the image to find out the value.



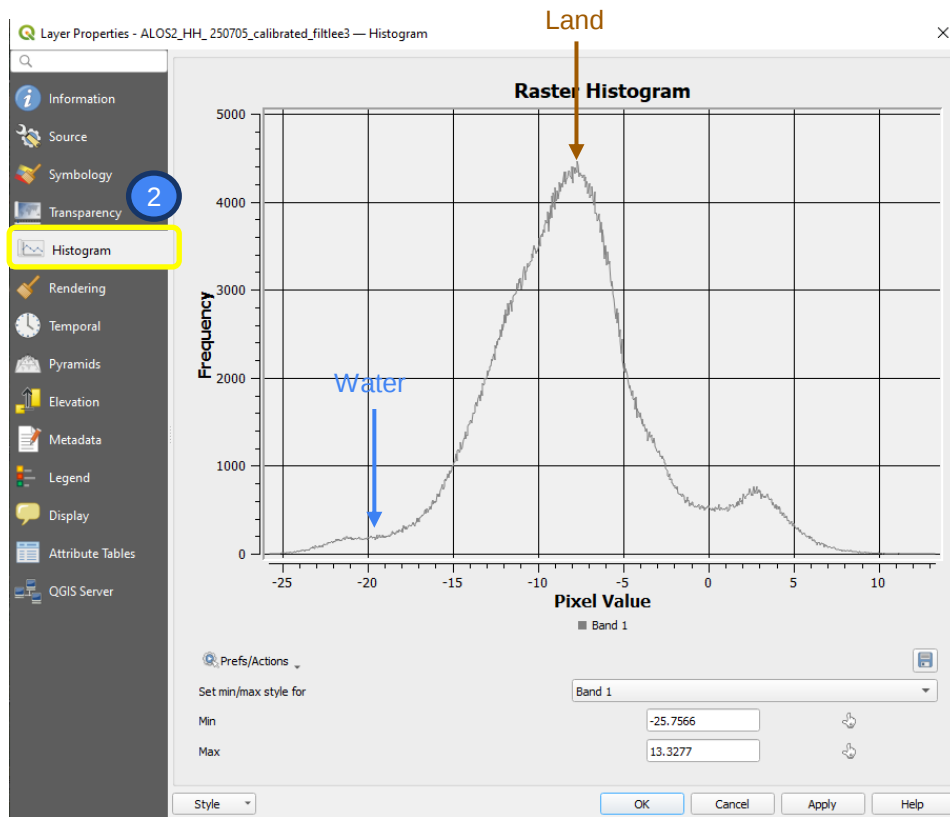
Feature	Value
ALOS2_HH_250705_calibrated_filtlee3	0
ALOS2_HH_250705_calibrated_filtlee3	
Band 1	-17.021355
(Derived)	

Determine a Threshold Value

Follow Along: (Option 2) Histogram analysis

Determine the threshold based on the histogram of the whole filtered image.

1. Right-click on the [ALOS2_HH_250705_calibrated_filtlee3](#) layer in the Layers list and select the menu item [Properties](#) in the menu that appears.
2. Select the Histogram tab 
3. In the Raster Histogram window, click [Compute Histogram](#) button.
4. A histogram is calculated. Ideally, we look for bimodal histograms, where water and land have two distinct peaks in the backscatter value distribution.



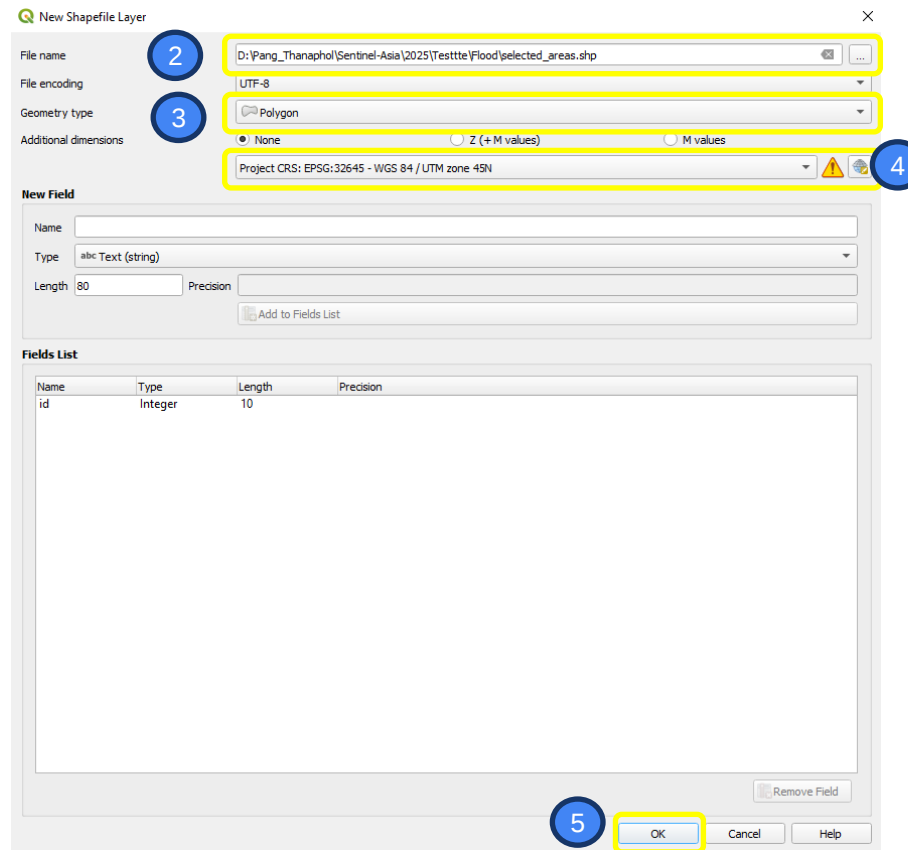
Determine a Threshold Value

Follow Along: (Option 2) Histogram analysis

Since the threshold between two peaks was difficult to get for the whole image histogram, we will determine the threshold based on the histogram of the selected areas.

First, we have to create a polygon shapefile with the selected areas:

1. In the Menu Bar, click on [Layer](#) → [Create Layer](#) → [New Shapefile Layer](#).
2. In File name, save the results as [selected_areas.shp](#).
3. In Geometry type, select [Polygon](#).
4. In Projection system, select [EPSG:32645 – WGS84 / UTM Zone 45N](#)
5. [OK](#).



The screenshot shows the 'New Shapefile Layer' dialog box with the following settings:

- File name:** D:\Pang_Thanaphol\Sentinel-Asia\2025\Testtite\Flood\selected_areas.shp
- File encoding:** UTF-8
- Geometry type:** Polygon
- Additional dimensions:** None (selected), Z (+M values), M values
- Project CRS:** EPSG:32645 - WGS 84 / UTM zone 45N
- New Field:** Name (empty), Type: abc: Text (string), Length: 80, Precision (empty)
- Fields List:** A table with columns Name, Type, Length, and Precision. It contains one entry: id, Integer, 10.

Numbered annotations on the image:

- 1: Points to the 'Layer' menu item in the top menu bar.
- 2: Points to the 'File name' field.
- 3: Points to the 'Geometry type' dropdown menu.
- 4: Points to the 'Project CRS' dropdown menu.
- 5: Points to the 'OK' button at the bottom right.

Go to editing mode to start digitizing:

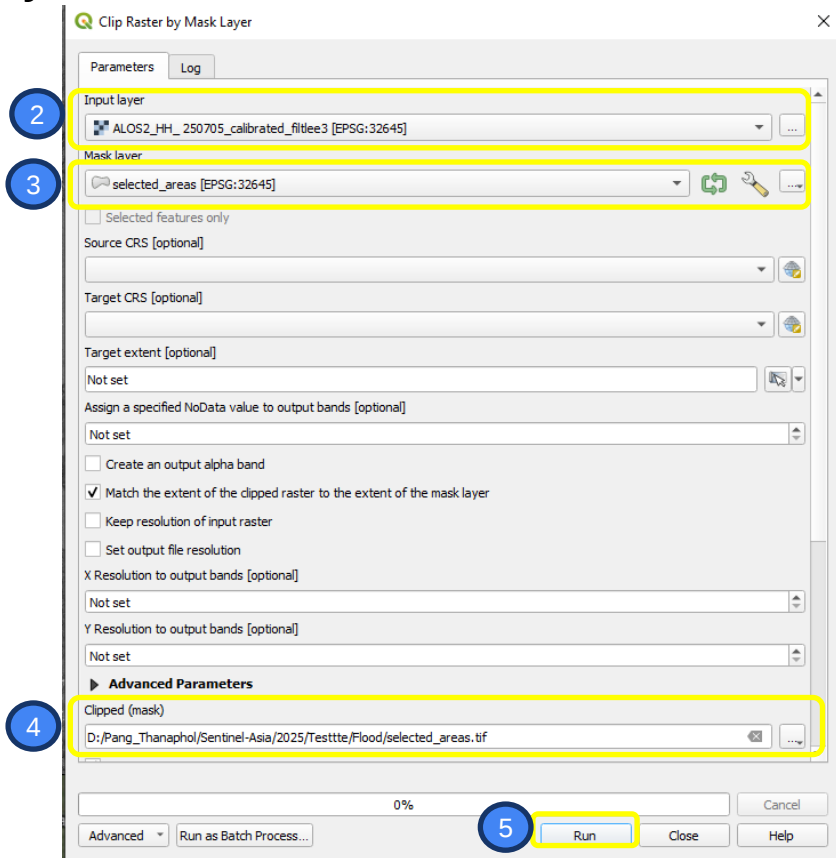
-

Determine a Threshold Value

Follow Along: (Option 2) Histogram analysis

Next, we will clip the image based on the created polygons:

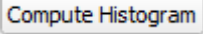
1. In the Menu Bar, click on **Raster** → **Extraction** → **Clip Raster by Mask Layer**.
2. In the Input Layer, select **ALOS2_HH_250705_calibrated_fitlee3**
3. In the Mask Layer, select **selected_areas**.
4. Save the result to **selected_areas.tif**.
5. Click **Run**.

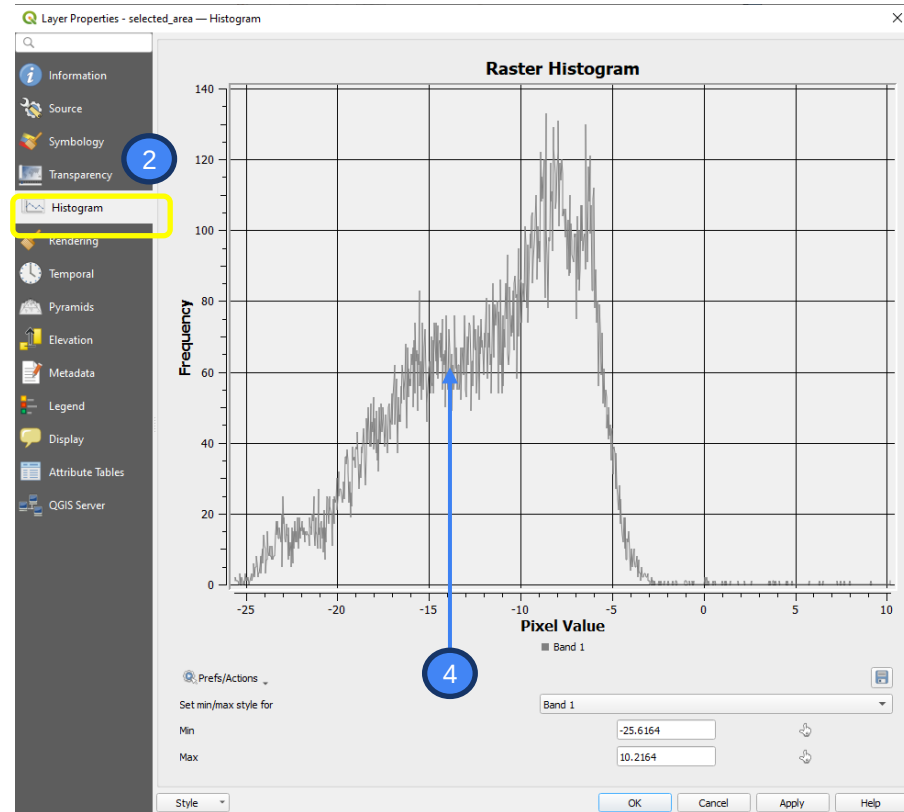


Determine a Threshold Value

Follow Along: (Option 2) Histogram analysis

Compute the histogram for the clipped image.

1. Right-click on the **selected areas** layer in the Layers list and select the menu item **Properties** in the menu that appears.
2. Select the Histogram tab 
3. In the Raster Histogram window, click **Compute Histogram**  button.
4. A histogram is calculated. Notice there are two histogram peaks now: the lower value refers to water pixels, while the higher value refers to non-water pixels.
5. Determine the threshold by identifying the pixel value between water and non-water: ~ -14 dB.

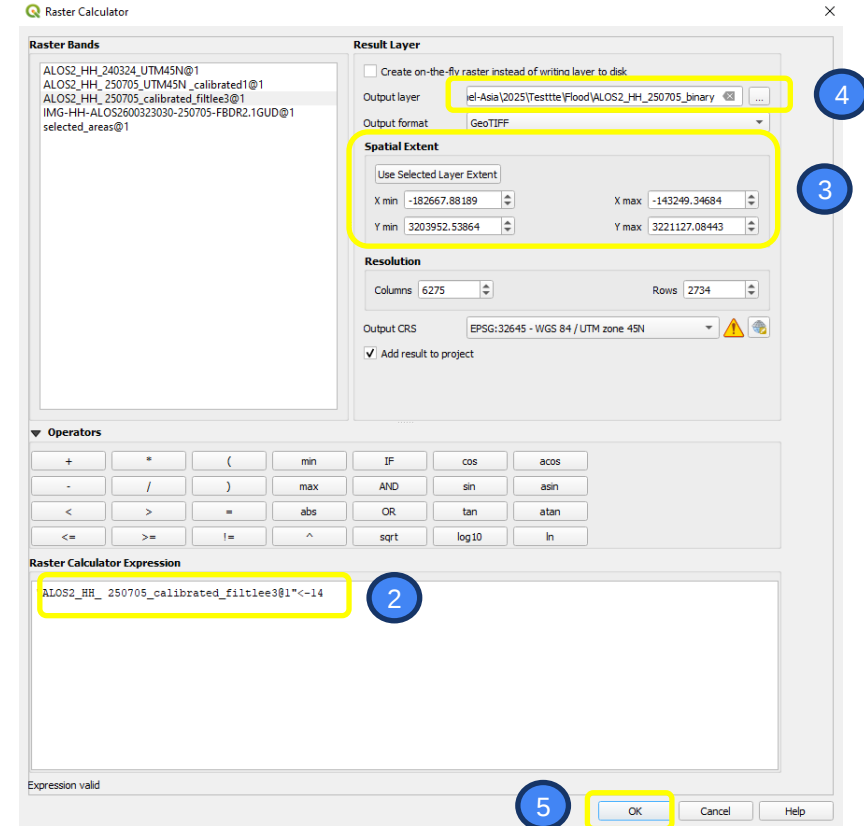


Binary Classification

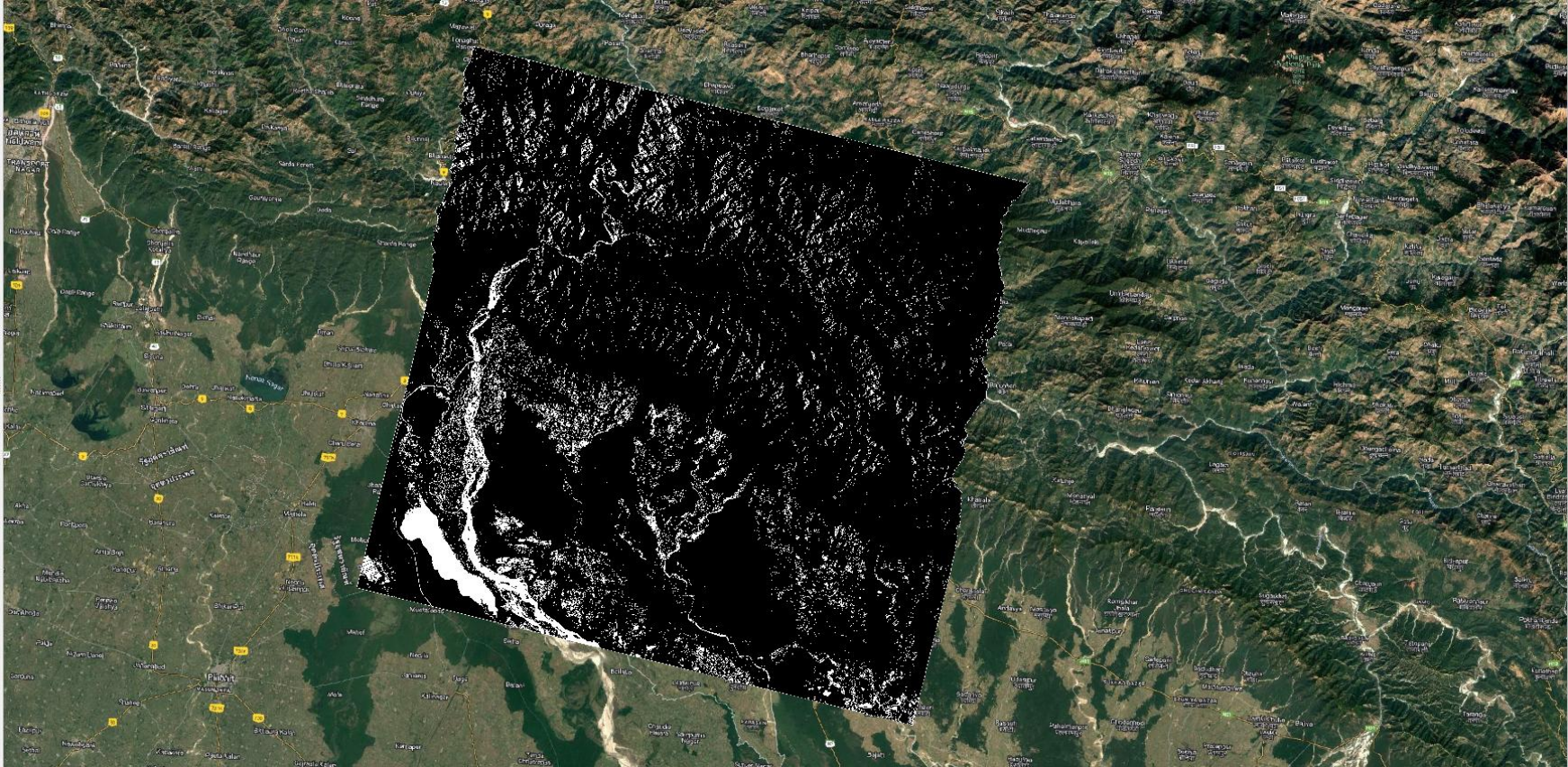
Follow Along: Create a binary map based on the threshold value

We will use the threshold value from the second option's result: -14 dB.

1. Click on **Raster** → **Raster Calculator**.
2. In the Raster Calculation Expression write: `"ALOS2_HH_250705_calibrated_filtlee3@1" < -14`
3. In the Spatial Extent, define the extent based on the image.
4. Save the result to `"ALOS2_HH_250705_binary.tif"`
5. Click **OK**.



Binary Classification Visualization

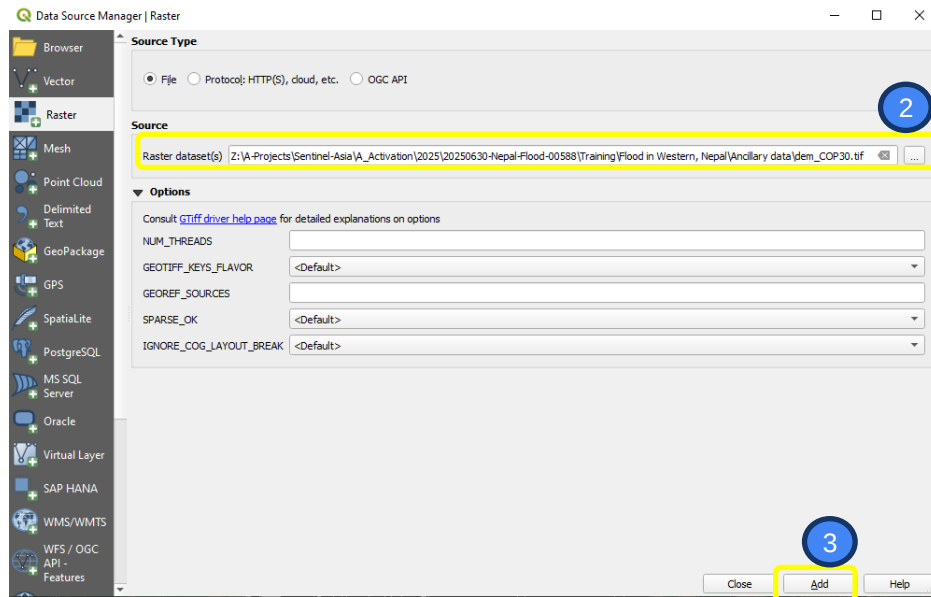


Post-processing

Follow Along: Eliminate pixels found in slope > 5 deg.

First, let's open DEM for the area, 30m Copernicus extracted from OpenTopography.

1. In the Menu Bar, click on **Layer** → **Add Layer** → **Add Raster Layer**.
2. In Data Source, click on the **Browse** button  and navigate to the file **dem_COP30.tif** in the ancillary data folder.
3. With this file selected, click **Add**, then **Close**. The data you specified will now load.



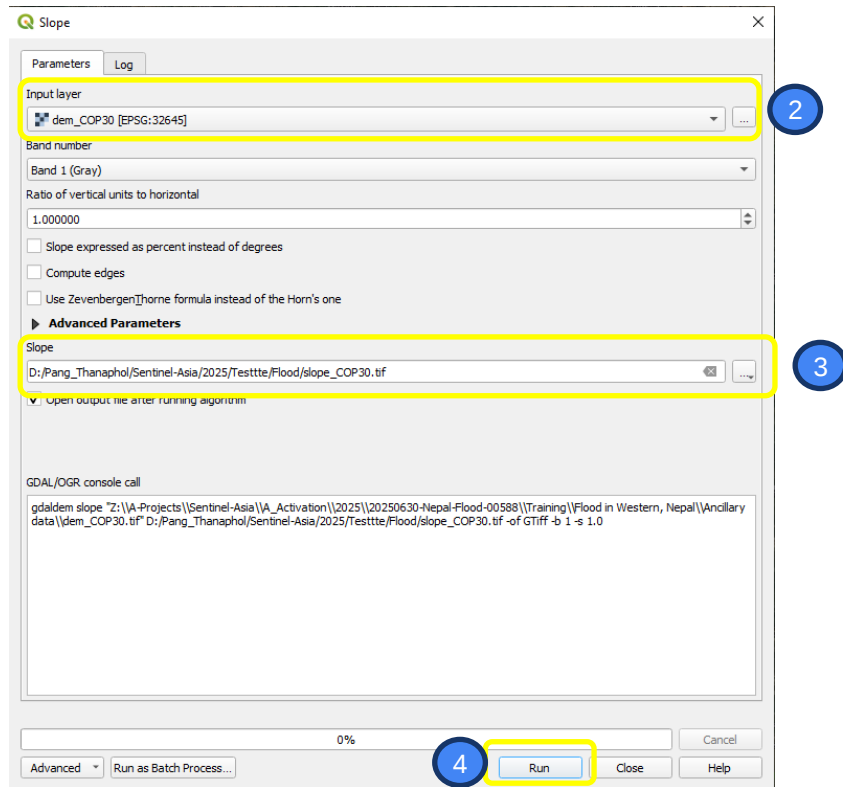
Post-processing

Follow Along: Eliminate pixels found in slope > 5 deg.

Now, we are ready to remove misclassified pixels in the regions of steep slopes.

First, let's calculate the slope from the DEM:

1. Calculate Slope: [Raster](#) → [Analysis](#) → [Slope](#).
2. In the Input Layer, select [dem_COP30](#)
3. Save the result to [slope_COP30.tif](#)
4. Click [Run](#).

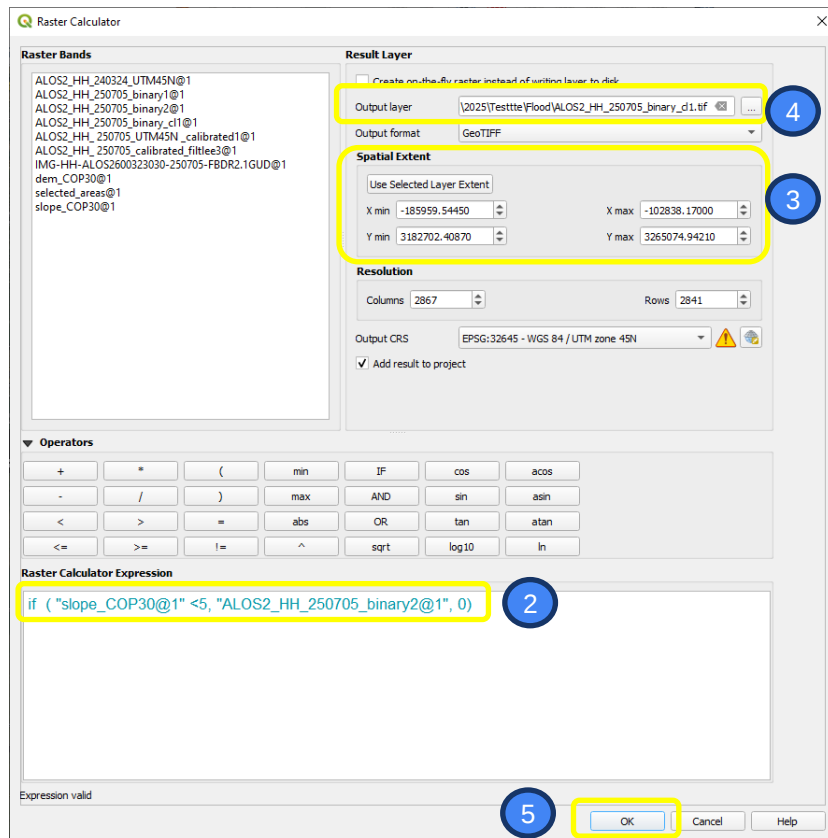


Post-processing

Follow Along: Eliminate pixels found in slope > 5 deg.

Use Raster Calculator to remove regions with a slope above 5 degrees.

1. Click on **Raster** → **Raster Calculator**.
2. In the Raster Calculation Expression write:
if ("slope_COP30@1" <5,
"ALOS2_HH_250705_binary2@1", 0)
3. In the Spatial Extent, define the extent based on the image.
4. Save the result to
ALOS2_HH_250705_binary_cl1.tif
5. Click **OK**.

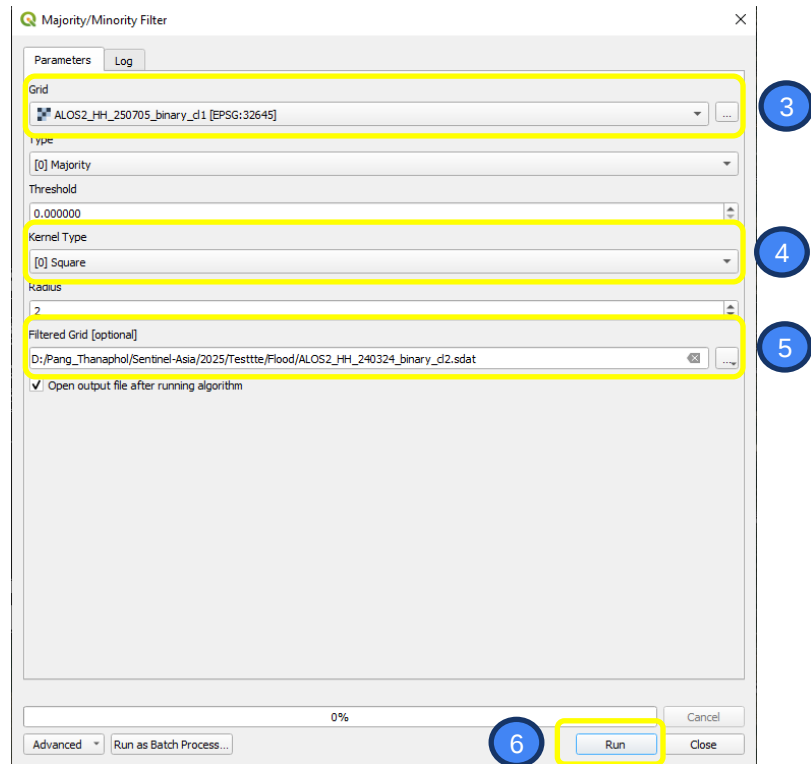


Post-Processing

Follow Along: Remove isolated pixels

We will remove small, isolated misclassified pixels or noise in the binary map using a majority filter.

1. In the Menu Bar, click [Processing](#) → [Toolbox](#).
2. Search for [SAGA Next Gen](#) → [Raster filter](#) → [Major/minority filter](#)
3. In the Grid input, select [ALOS2_HH_250705_binary_cl1](#).
4. Change Kernel Type to [Square](#) and keep other parameters as default. You may want to test with different threshold and radius.
5. Save the result to [ALOS2_HH_250705_binary_cl2.sdatt](#)
6. Click [Run](#)

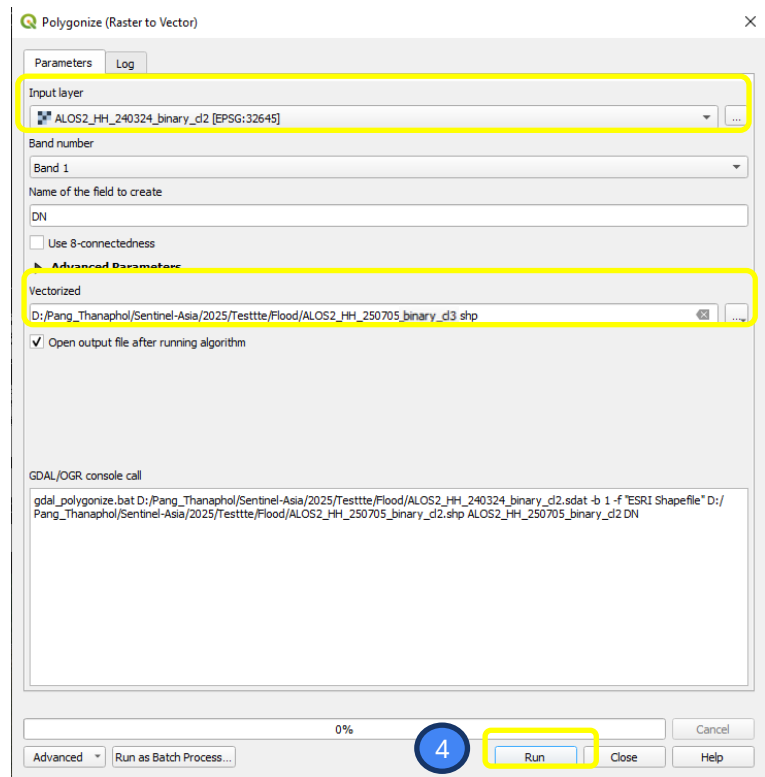


Post-Processing

Follow Along: Vectorize flood pixels

We will convert the flood raster to polygons.

1. Click on **Raster → Conversion → Polygonize (Raster to Vector)**...
2. In the Input Layer, select **ALOS2_HH_250705_binary_cl2**
3. Save the Vectorized result to **ALOS2_HH_250705_binary_cl3.shp**
4. Click **Run**.



Post-processing

Follow Along: Remove non-water polygons

Let's remove non-water polygons.

1. In Toolbars, activate the editing mode by clicking the [Toggle Editing](#)  button.
2. In Toolbars, click [Select Features by Value](#)  button or click F3.
3. In the DN value, write [0](#).
4. Click [Select Features](#), then [Close](#).
5. In Toolbars, click [Delete Selected](#)  button to delete non-water polygons.
6. Click [Toggle Editing](#)  button again to stop the editing, then select [Save](#).

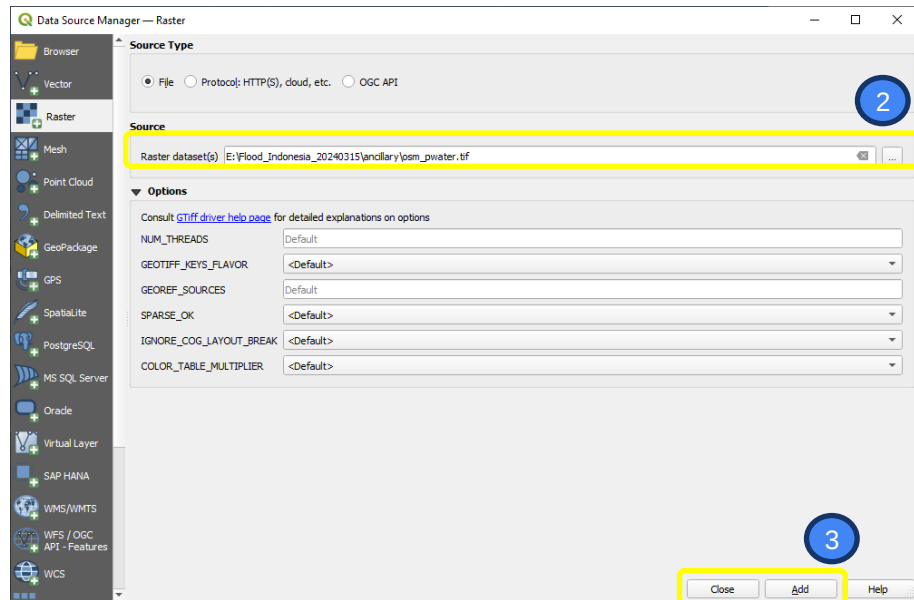


Post-processing

Follow Along: Eliminate permanent water areas

First, let's open permanent water data for the area, extracted from OSM.

1. In the Menu Bar, click on **Layer** → **Add Layer** → **Add Vector Layer**.
2. In Data Source, click on the **Browse** button  and navigate to the file **OSM_permanent_water.shp** in the ancillary data folder.
3. With this file selected, click **Add**, then **Close**. The data you specified will now load.

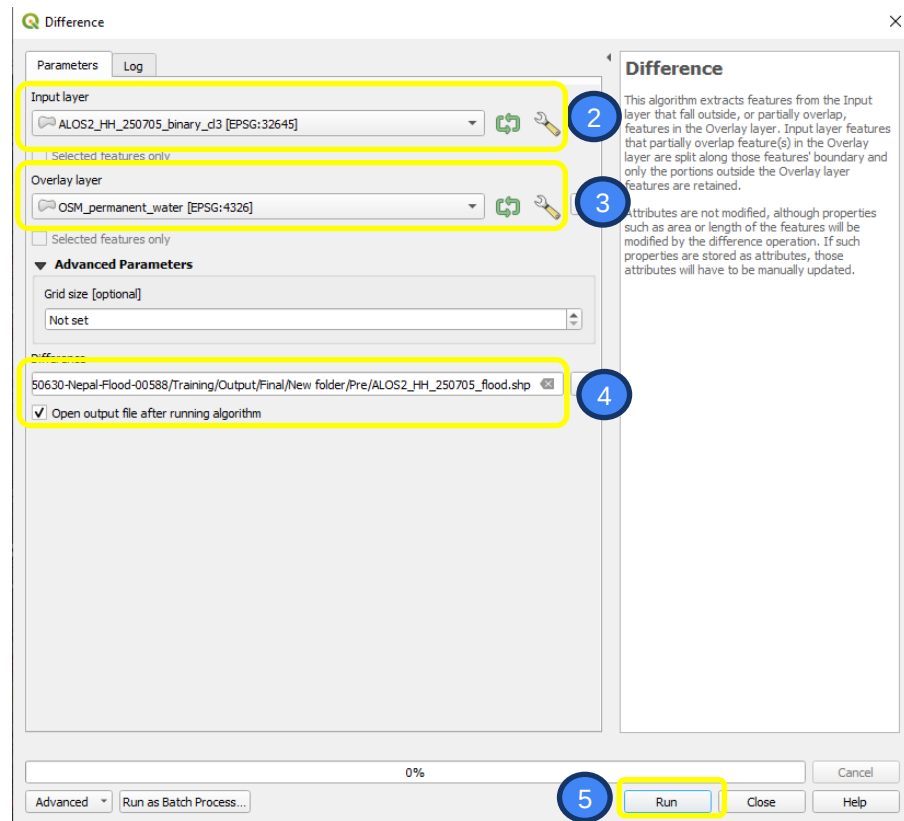


Post-processing

Follow Along: Eliminate permanent water areas

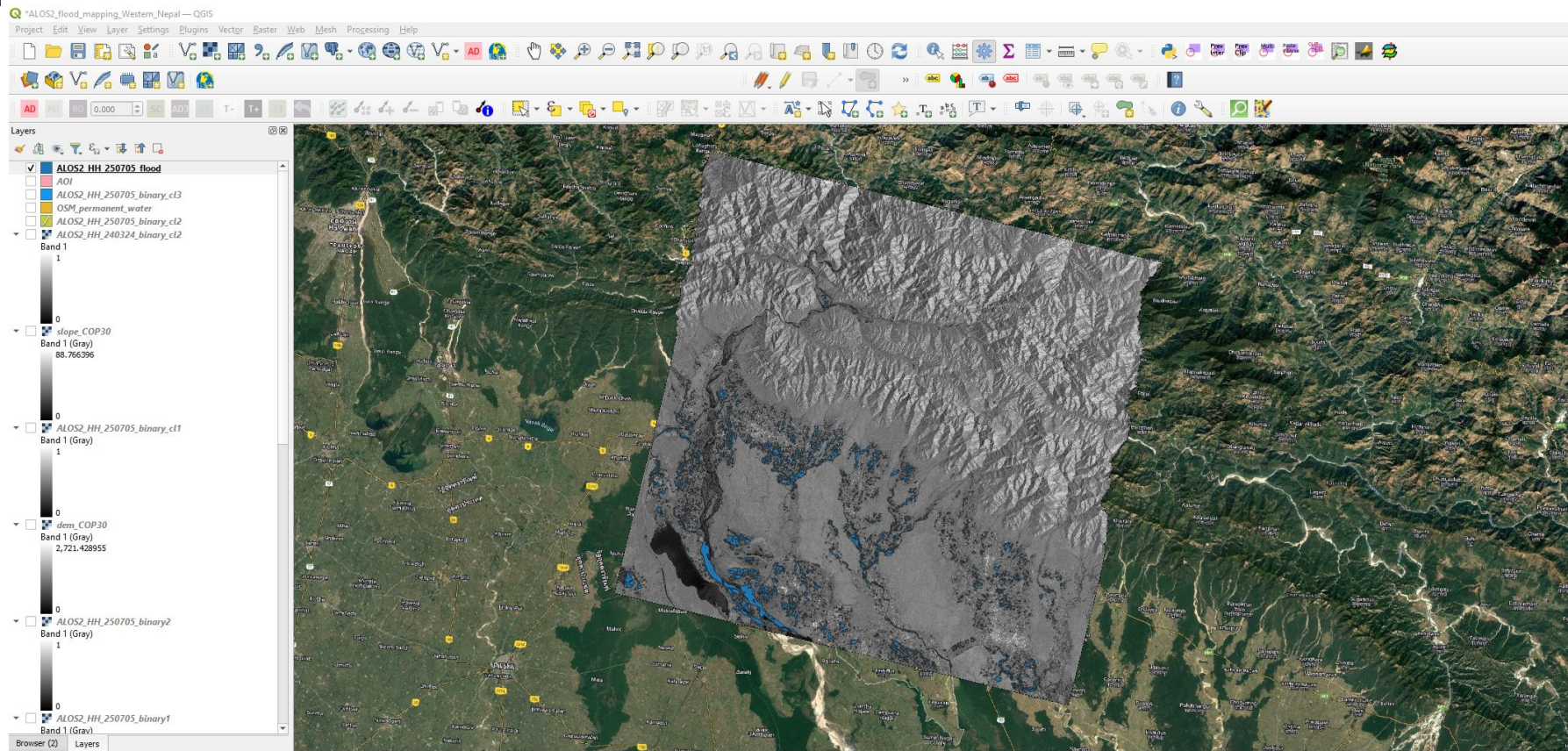
Use Difference to eliminate permanent water areas.

1. Click on **Vector** → **Geoprocessing tool** → **Difference**.
2. In the Input Layer, select :
ALOS2_HH_250705_binary_cl3.shp
3. Overlay layer, select:
OSM_permanent_water.shp
4. Save the Difference result to
ALOS2_HH_250705_flood.shp
5. Click **OK**.



Post-processing

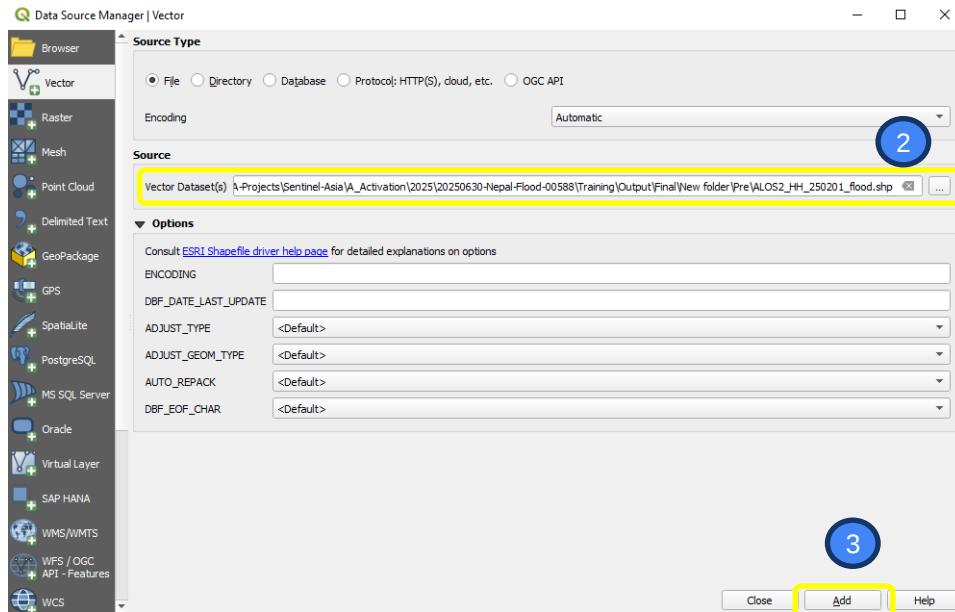
Final visualization for single post-disaster data



Change detection

First, let's open ALOS2_HH_250201_flood.shp shapefile.

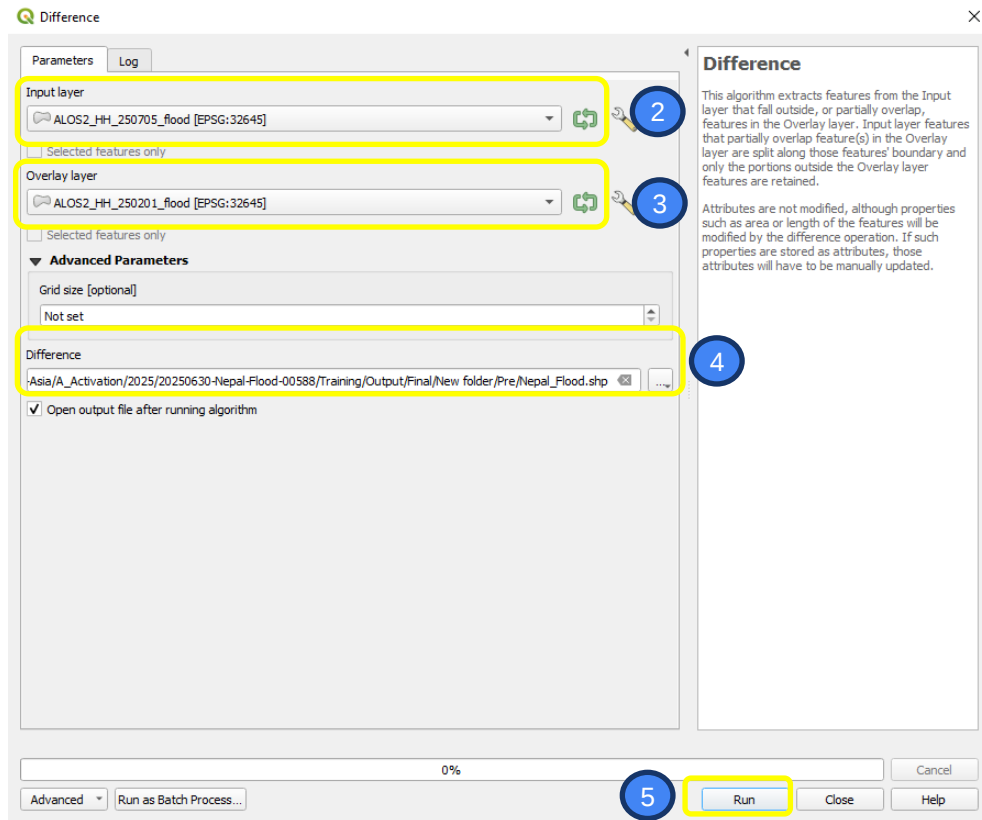
1. In the Menu Bar, click on **Layer** → **Add Layer** → **Add Vector Layer**.
2. In Data Source, click on the **Browse** button  and navigate to the file **ALOS2_HH_250201_flood.shp** in the ancillary data folder.
3. With this file selected, click **Add**, then **Close**. The data you specified will now load.



Change detection

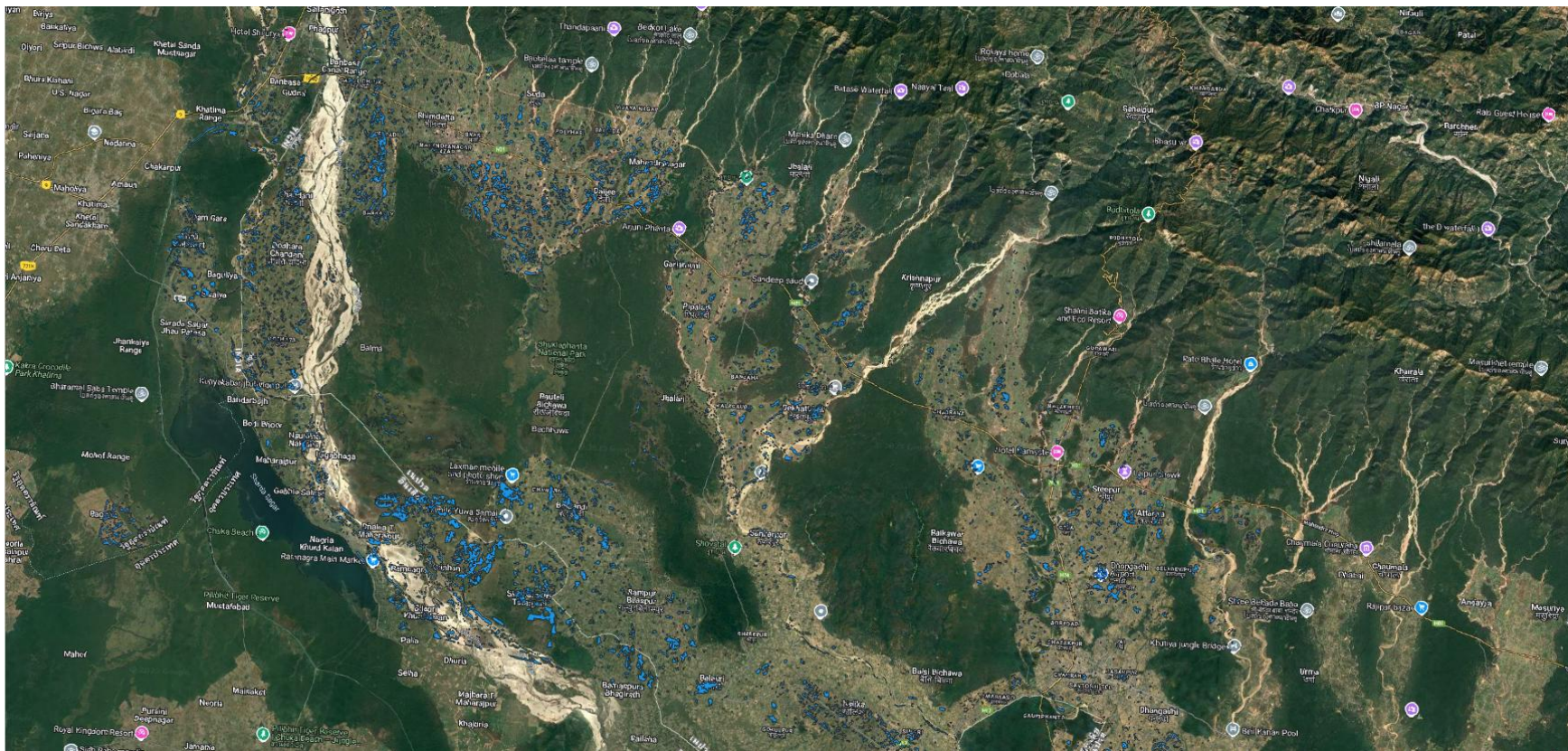
Use the Difference operation to subtract the water area from the pre-image out of the post-image.

1. Click on [Vector](#) → [Geoprocessing tool](#) → [Difference](#).
2. In the Input Layer, select :
[ALOS2_HH_250705_flood](#)
3. Overlay layer, select: [ALOS2_HH_250201_flood](#)
4. Save the Difference result to [Nepal_Flood.shp](#)
5. Click [OK](#).



Post-processing

Final visualization for flood detection



THANK YOU

Geoinformatics Center, Asian Institute of Technology

