GNR 639 (Disaster Management) ASSIGNMENT 2

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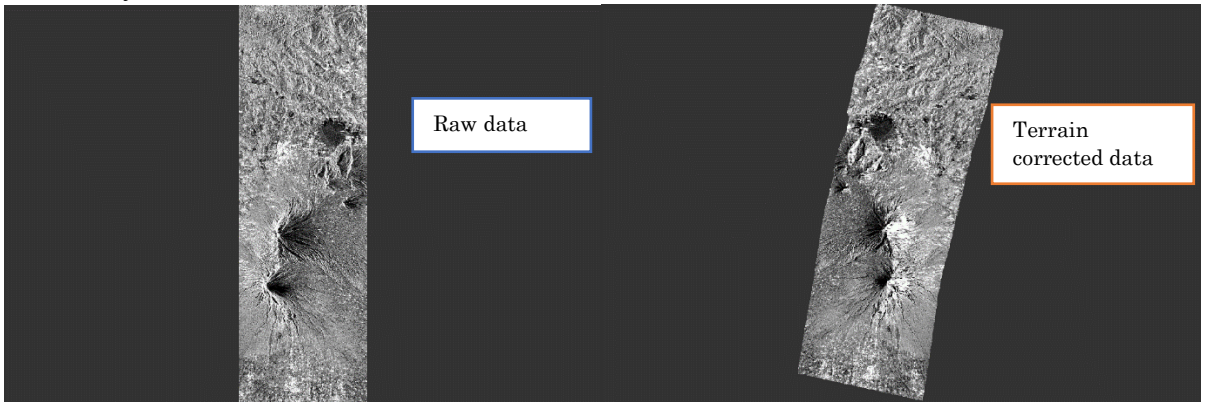
Analysis of Volcanic Post Eruption data (12th December 2010)

σ_0 Based Analysis

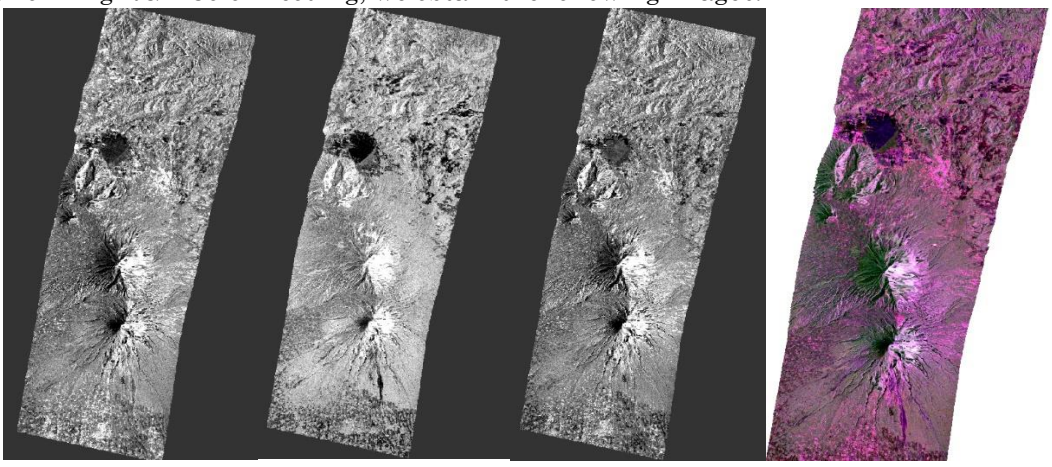
Steps carried out:

- Download volcanic post data
- Calibrate the image (dB for back-scattering), Performed dB calibration and obtain `Data(2)`: Bands which contains: `Sigma0_HH_dB, Sigma0_HV_dB, Sigma0_VH_dB, Sigma0_VV_Db`
- For Multi-looking, Perform: `RADAR > SAR Utilities > Multi-looking` and select Data(2), change settings to `2:11`
- Perform Terrain Correction by `RADAR > GEOMETRIC > TERRAIN CORRECTION > RANGE-DOPPLER TERRAIN CORRECTION`. Terrain Correction is very important to fit the data on to the ground.

Terrain correction is emphasized in this analysis because of the high altitude of the volcano. We can clearly see the difference between the raw data and the terrain corrected data.



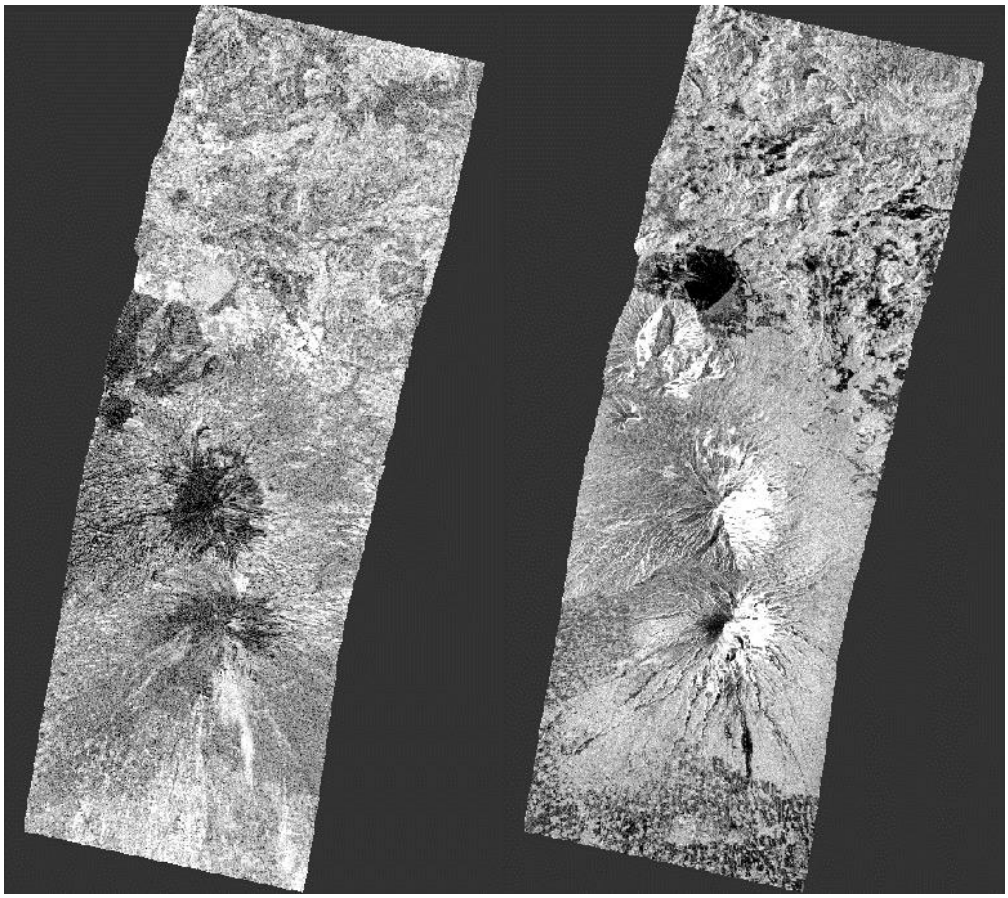
- Performing RGB Colour-coding, we obtain the following images:



HH Band ~R	HV Band~G	VV Band~B	RGB Coded image

Analysis of the bands:

From the RGB coded image, we can infer that there is significant contribution from the HV band and the HH band, compared to the VV band. To illustrate this further, I will develop the difference image of HH and HV (Difference between co-polarised and cross-polarized bands) in dB scale.



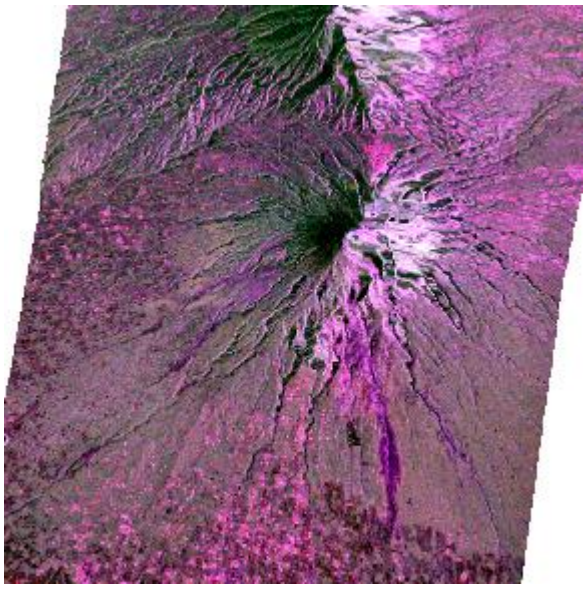
LEFT:

HH-HV band in dB scale

RIGHT:

HV band in dB scale

We can observe that there is pyroclastic flow in the lower right half, which is reflected by a higher magnitude in the quantitative scale.



PYROCLASTIC FLOWS:

A **Pyroclastic flow** is a dense, fast-moving **flow** of solidified lava pieces, volcanic ash, and hot gases. It occurs as part of certain volcanic eruptions.
A **pyroclastic flow** is extremely hot, burning anything in its path. It may move at speeds as high as 200 m/s.

Hence, Back scattering (σ_0 Based Analysis) is a reasonably efficient method to detect volcanic pyroclastic flows.

However, we will also apply Polarimetric-Decomposition based

Polarization Decomposition Analysis

Steps carried out:

- Close all the products and re import the initial data, and calibrate it, and while doing so, click on "Save as Complex Output"
- Perform the following: `RADAR > POLARIMETRIC > POLARIMETRIC MATRIX GENERATION` and click T3 Matrix (Selecting T4 or C2 may affect the decomposition)
- After decomposing, we can find the 9 elements (T_{11}, T_{22}, T_{33}, T_{12}, T_{12}*, T_{13}, T_{13}*, T_{23}, T_{23}*). The components with complex numbers will be given after simplification as follows:

  $T_{12}{}^{real} = \frac{1}{2}(T_{12} + T_{12}*)$

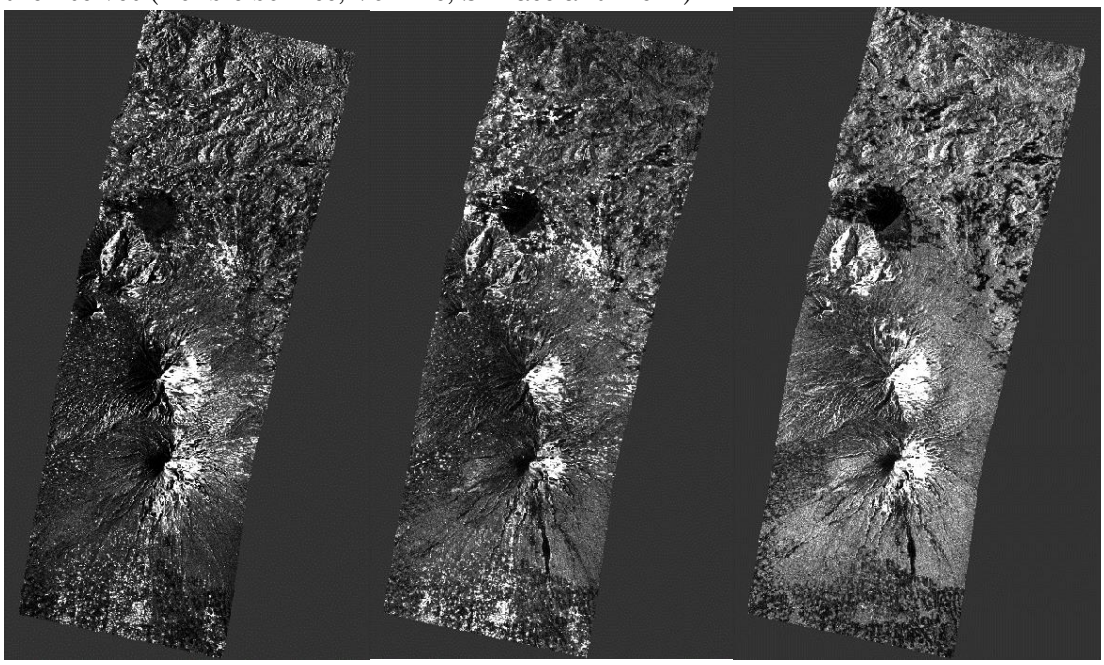
  $T_{12}{}^{imaginary} = \frac{1}{2}(T_{12} - T_{12}*)$

  $(and\ the\ same\ applies\ to\ the\ rest\ of\ the\ T_{ij})$

The theory has been explained in Assignment 1 (Earthquake/Tsunami)

- The next step is multi-looking. We restrict the range looks to 2 and azimuth to 11 as usual.
- Apply Range-Doppler terrain correction to the multi-looked data.

  The component pictures (T_{11}, T_{22}, T_{33})are all attached below for reference. Note that these are just components of the matrix and say nothing about the types of scattering themselves (Double bounce, Volume, Surface and Helix)



T_{11}	T_{22}	T_{33}

There are 6 other components in the matrix. (T_{12}, T_{12}*, T_{13}, T_{13}*, T_{23}, T_{23}*).

$T_{12}{}^{real} = \frac{1}{2}(T_{12} + T_{12}*)$

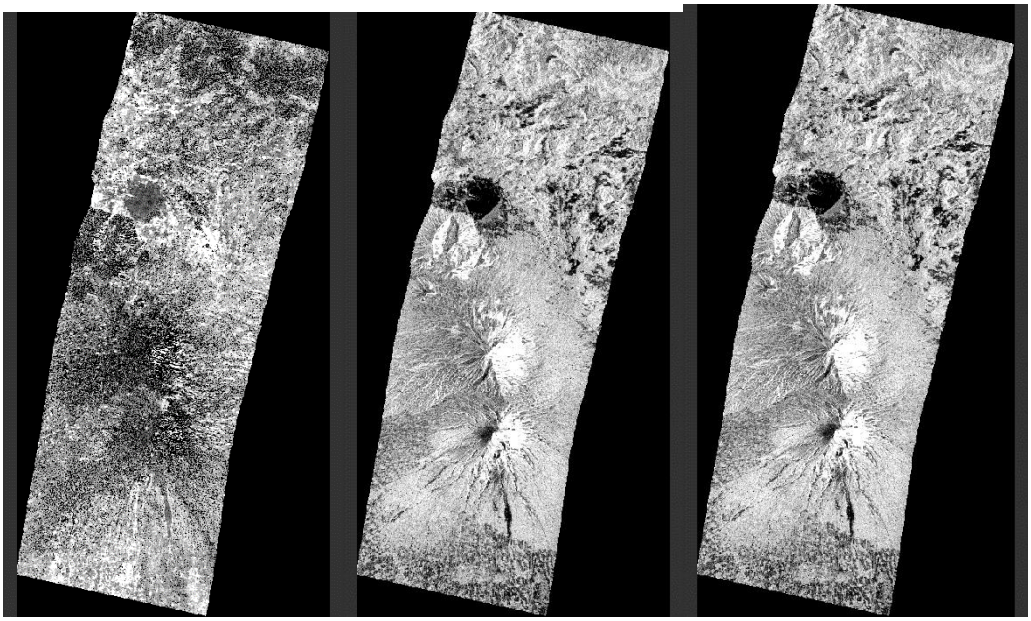
$T_{12}{}^{imaginary} = \frac{1}{2}(T_{12} - T_{12}*)$

- Carry out Polarimetric decomposition as follows:

  `RADAR > POLARIMETRIC > POLARIMETRIC DECOMPOSITION`

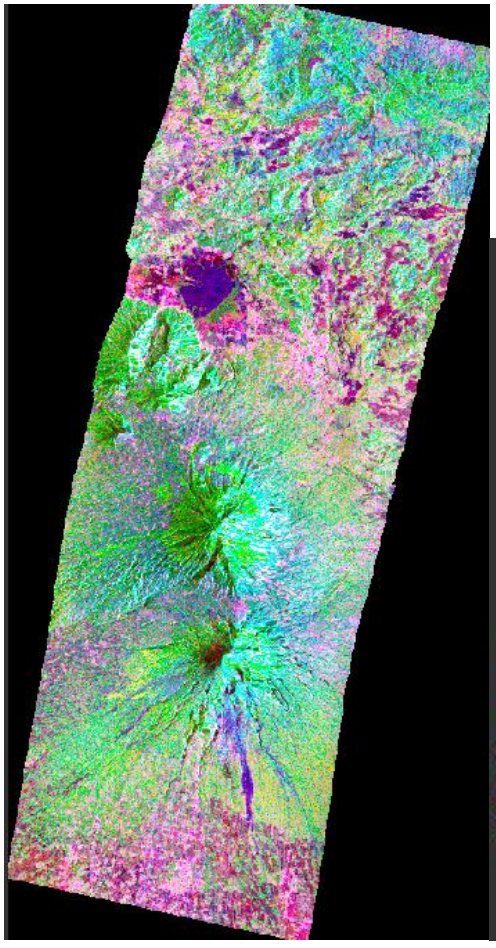
  Set processing parameters as Yamaguchi decomposition with Window size 1.
- Now, finally colour code the image as RGB, which is saved by default.

Attached below are individual Double bounce, Volume and Surface scattering bands:



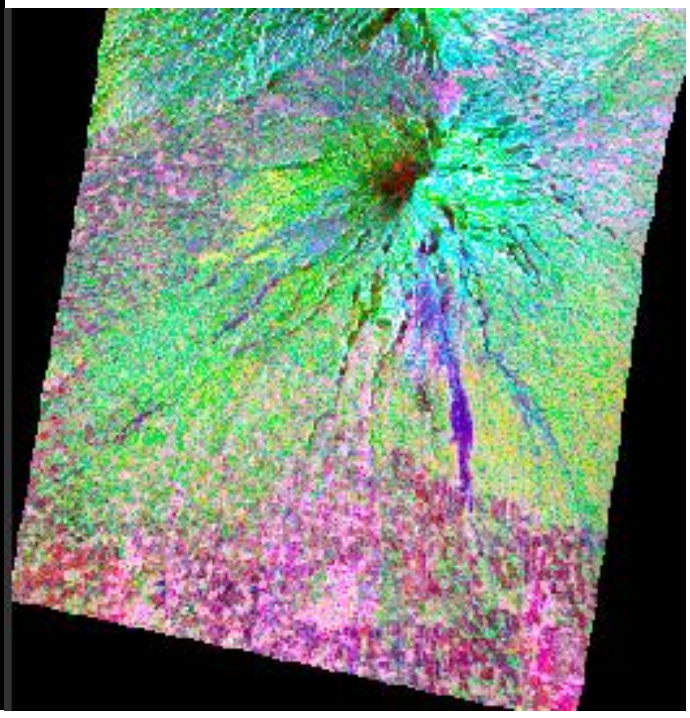
Yamaguchi~R Double Bounce	Yamaguchi~G Volume	Yamaguchi~B Surface

The superimposed RGB image is as follows:



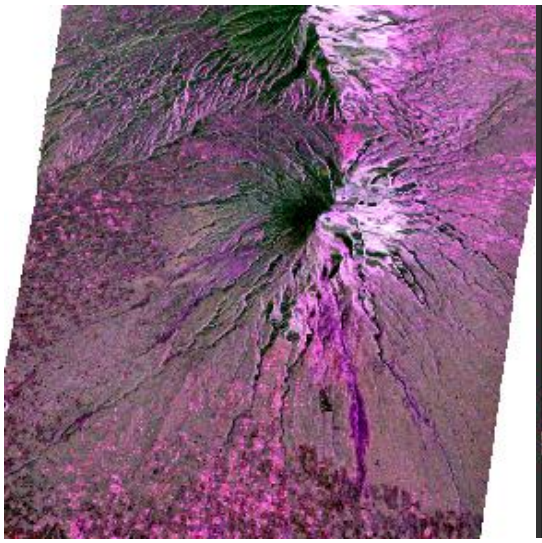
LEFT: Superimposed RGB image

BELOW: Zoomed image near area of eruption (Post data) of Mt. Merapi

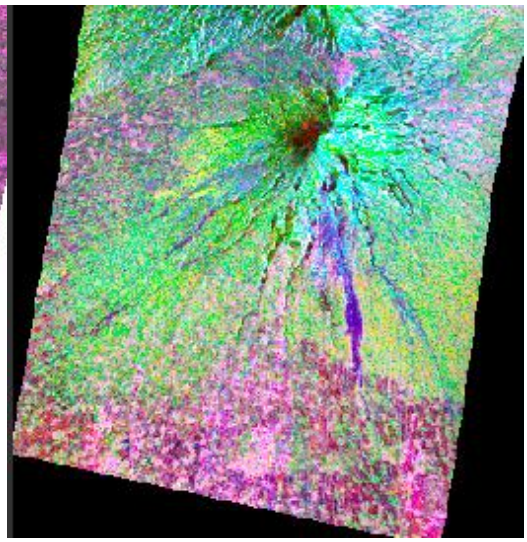


Inferences:

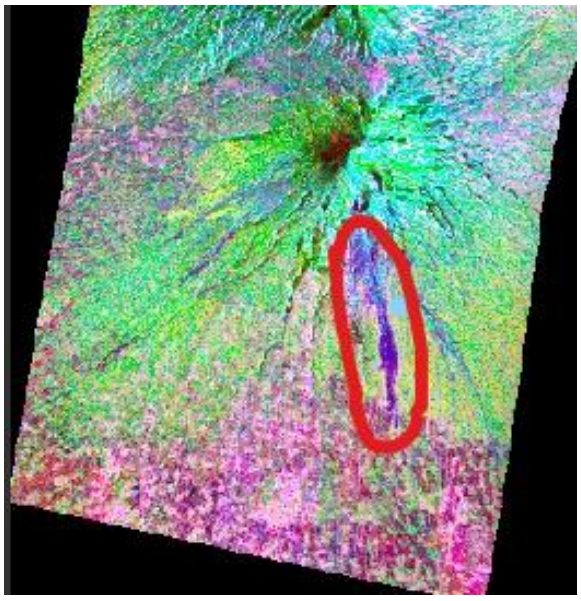
- From the predominant Double bounce scattering in the region below, we can infer that it is an urban area (Presence of buildings, houses and structures.
- Presence of green indicates high altitudes and terrain, in this case the volcanic edifice and the mountain.
- The pyroclastic flow can be inferred from both Back-scattering bands and Polarization decomposition bands and can be seen with the naked eye:



σ_0 Based Analysis *(Back scattering)*



Polarization Decomposition Analysis



Pyroclastic flow has been circled in red