ADVACNCED REMOTE SENSING

Radar Assignment

Submitted By: Hira Zafar

03-11-2020

Description of the Analysis and Results:

The focus of this exercise was on change detection identifying burned areas by using multi-temporal images of sentinel-1 and SNAP toolbox. Study area is located in Andalusia region, Spain. Pre-fire image 02July2017 and Post-fire image 19Aug2017 were used for analysis. Both VH and VV polarizations were considered. Before the analysis, preprocessing was performed to make data ready for analysis, which consisted of following steps: 1) the orbital correction of the datum was performed exploiting the knowledge of the orbital position of the sensor; 2) the calibration was done to extract physical information from the SAR backscattering. This process is essential for analyzing the images in a quantitative way and it is mandatory for comparing images from different sensors, modalities, processors or acquired at different times, as in the current analysis; 3) the coregistration (to ensure that two or more images are overlapping) was performed selecting an image as reference and then coregistering all the subsequent images with respect to it; 4)Geometric Correction: The SAR data is usually measured in varying viewing angle, which can result in some distortion related to side-looking geometry. Terrain correction compensates for these distortions. Range Doppler terrain correction is a correction of distortions due to topography, using DEM to correct the location of each pixel and 5) the filtering speckle to reduce the salt and pepper effects was done using the well-known Lee filter.

To assess the capability of Sentinel-1 in the identification of burned areas, both the VV and VH polarizations were investigated, using: 1) single-date scene acquired prefire and postfire. The simple change detection method for Radar imagery in SNAP toolbox was used to identify burned areas. The most marked differences between burned and unburned areas were observed in the VH polarization. The main difference visible is that the fire-affected area exhibits a strong patch homogenization that is very clear from a visual comparison of the texture between fire-affected and fire unaffected areas. The visual comparison clearly highlights that VH polarization (shown in the Fig. 1) tend to exhibit a higher contrast between burned and unburned areas.

VH Polarization

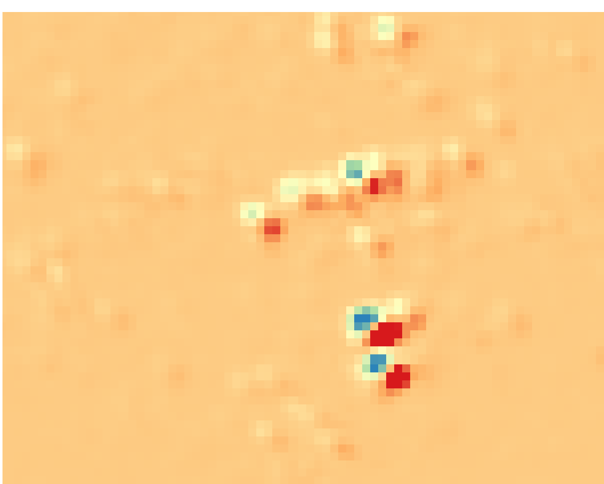


Fig. 1

VV Polarization

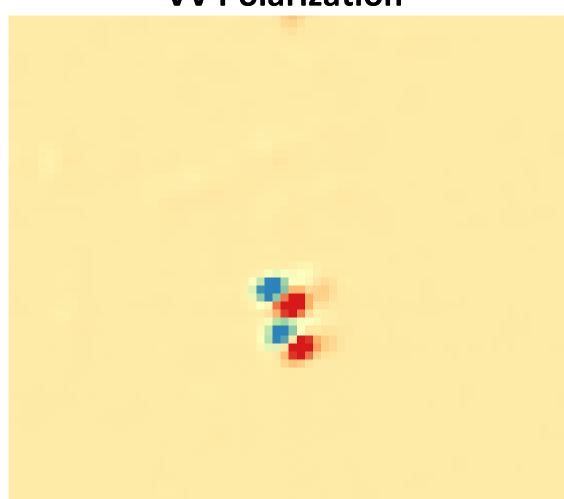


Fig. 2

The red areas show high burned areas while cyan areas moderately burned areas.

Question 1) find the following information in the metadata folder:

-Flight direction: descending for both images
S1B_IW_GRDH_1SDV_20170702T062605_..._027894_6DA0: Descending

S1B_IW_GRDH_1SDV_20170819T062608_..._00C576_066C: Descending

Polarizations: Can be found under mds1_tx_rx_polar and mds2_tx_rx_polar

S1B_IW_GRDH_1SDV_20170702T062605_..._027894_6DA0: VH; VV

S1B_IW_GRDH_1SDV_20170819T062608_..._00C576_066C: VH; VV

Question 2) what is VV and VH stands for?

The electromagnetic waves transmitted by the radar antennas can have the vibrations restricted to a specific direction. The two common polarizations are Horizontal Linear polarization (H) and Vertical Linear polarization (V).

- VV - for vertical transmit and vertical receive, (**VV**)
- VH - for vertical transmit and horizontal receive(**VH**)

Questions 3) what is the difference between amplitude band and intensity band for each polarization?

Radar transmits a EMW in a given polarization and measures the backscattered wave contribution in a given polarization.

Amplitude band is the measurement of Amplitude and phases of backscattered waves.

In intensity bands resolution pixels are the measure of square of amplitude.

In general, the amplitude band images are brighter than the intensity band images for both the polarizations. Also, the intensity band images have higher contrast that amplitude band images

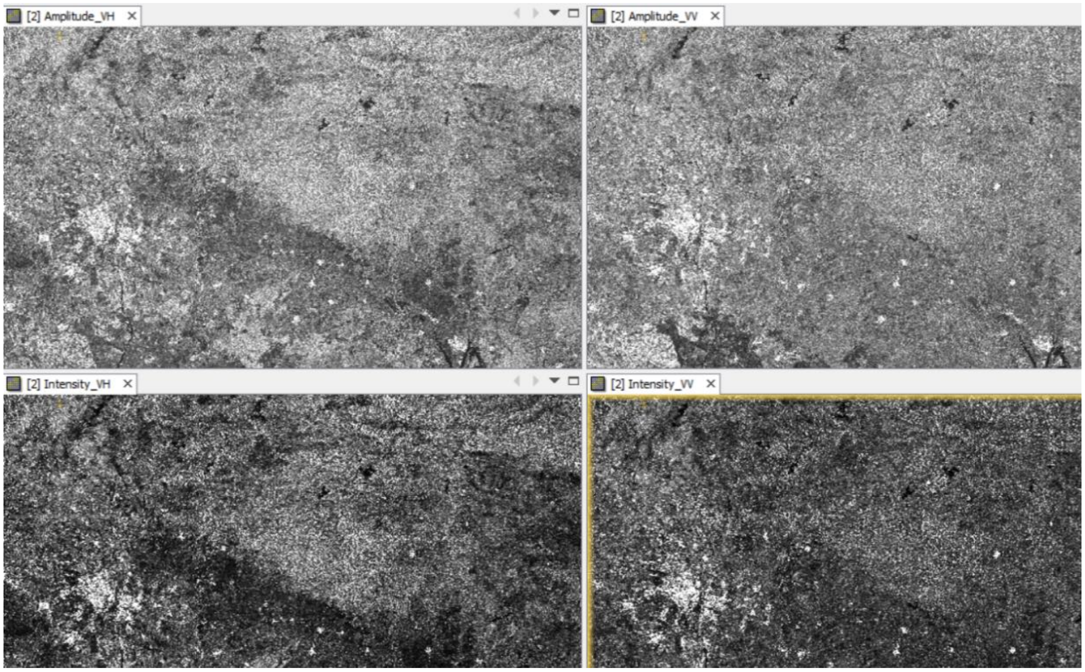
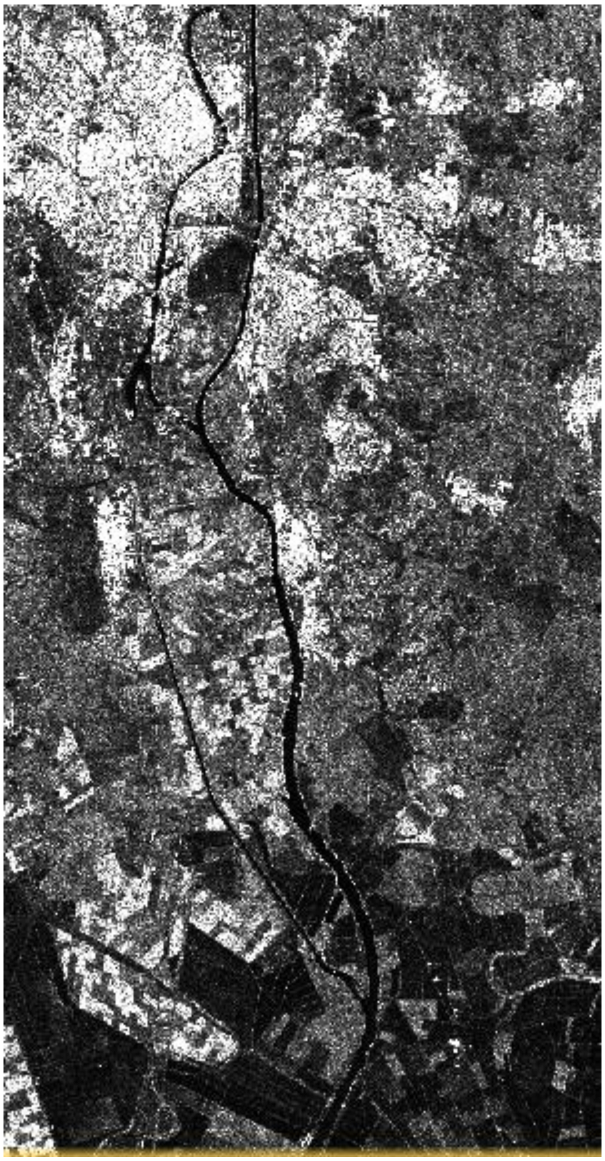


Figure 3: Amplitude and Intensity band for S1B_IW_GRDH_1SDV_20170819T062608_..._00C576_066C

Question 4) describe the differences between VV and VH polarizations for each of the example areas.

Intensity VV



Intensity VH

Well defined rectangular blocks show agricultural land, bright pixels are the urban area and the river appears as dark black

VV polarization show better identification of urban areas as compared to VH polarization, manmade features in urban area like buildings transmit coherent backscattered signals and due to double bounce they can be identified as bright points and easily identifiable. Co-polarized signals (HH, VV) are strong as compared to cross-polarized signals (HV, VH) and there is more noise in VH. When city streets or buildings are together in a row then the radar pulses go through a double bounce by bouncing off the streets and then again by the buildings and then are directly captured by the radar antenna making them appear very bright. Roads are flat surfaces where only reflection takes place and so they appear black. The agricultural land is well distinguishable because of its well organized structure of rectangular blocks. Cereal crops are also more distinguishable in VV polarization because it maximizes canopy penetration and enhances the contrast between vegetation. Water bodies are totally black because in case of calm and open water bodies, the incoming signal gets mirrored at the surface. Due to the side looking geometry of the sensor, a large proportion of the waves are just heading on in look direction instead of returning to the sensor.This leads to a very small proportion of backscatter for these surfaces (low values, black pixels). The river is similar in both the bands

Question 5) Why do we need to apply orbit file correction?

Orbit state vectors, contained within the metadata information of SAR products, are generally not accurate. Satellites precise orbit are determined after few days and are available days-to-weeks after the generation of the product. The operator to apply precise orbit available in SNAP allows to automatically download and update the orbit state vectors for each SAR scene in its product metadata, providing accurate satellite position and velocity information.

Question 6) There are three products available, sigma0, gamma0, and beta0. Describe each of them. For which application can we use sigma, gamma, or beta?

Sigma: The normalized measure of the radar return from a distributed target is called the backscatter coefficient, or sigma nought, and is defined as per unit area on the ground.

Beta: Beta Nought is a measure of the backscatter that is returned to the antenna from a distributed scatterer on the ground. Beta Nought contains a geometric impact on the radar backscatter, for example, bright pixels in foreshortened areas.

Gamma: It defines the relationship between a pixel's numerical value and its actual luminance. Without gamma, shades captured by digital cameras wouldn't appear as they did to our eyes (on a standard monitor). It's also referred to as gamma correction, gamma encoding or gamma compression. When a digital image is saved, it's therefore "gamma encoded".

Applications:

A ***Beta Nought*** image is useful to compare images of different SAR sensors or different times and provides rough information about surface scattering mechanisms and surface properties.

Sigma Nought is often used in scientific interpretation of SAR imagery. As the pixel values are absolutely calibrated, different SAR images in Sigma Nought notation can easily be compared. Additionally, experienced interpreters are able to retrieve information about surface scattering mechanisms and surface properties. In a Sigma Nought image, the topographic impact on the backscatter is minimized. The backscatter depends on surface backscatter properties and the image looks "flat".

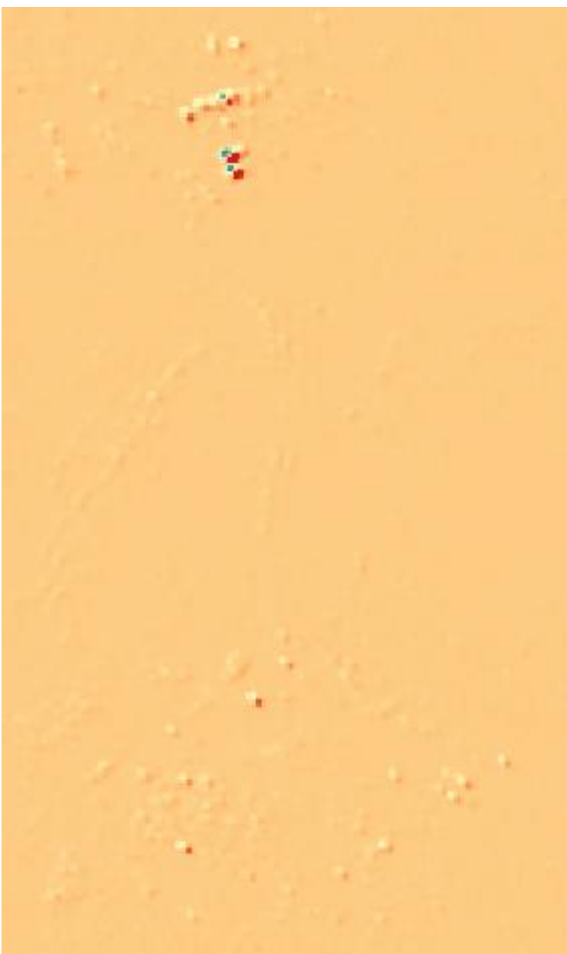
Gamma correction is applied for image enhancement, luminance correction with gamma correction, the (updated) color values work more nicely together and darker areas show more details.

Question 7) Perform comparison between change detection results derived from VV against VH polarizations. Describe your results.

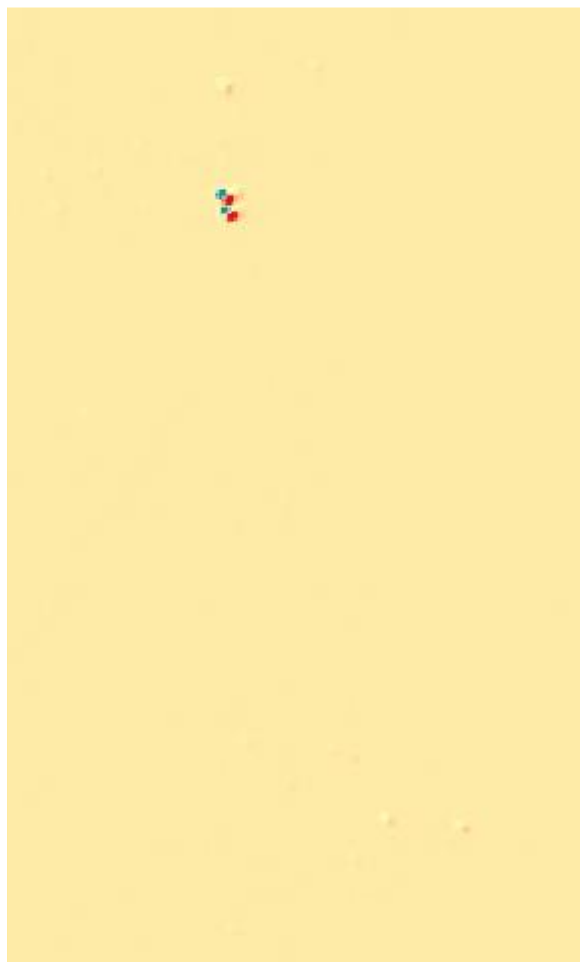
I saved the change detection results as Geotiffs and visualized them in QGIS. Change detection was visible in VH polarization as compared to VV polarization. The potential of using SAR for the mapping of burned areas mainly lies in the sensitivity of SAR backscatter to vegetation moisture content. Nevertheless, up until now, under different conditions, SAR backscatter was found to exhibit either an increase or decrease associated with burned conditions. the crosspolarized VH backscatter increased with burn severity and hence showed better potential for detecting burned areas.

Below is the comparison between VV and VH polarization.

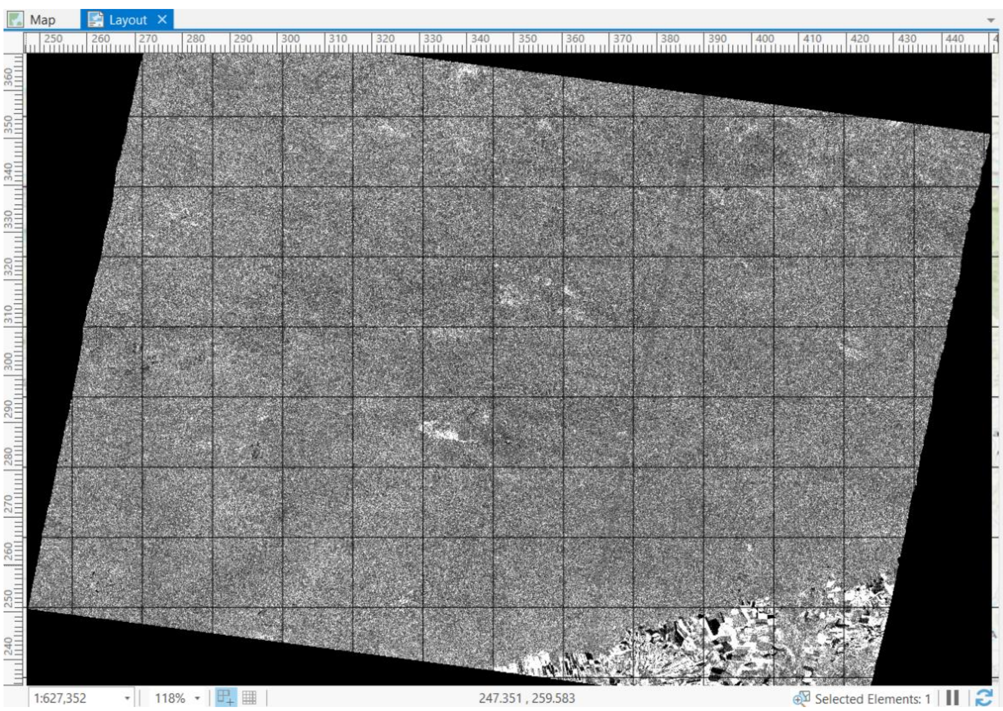
VH Polarization



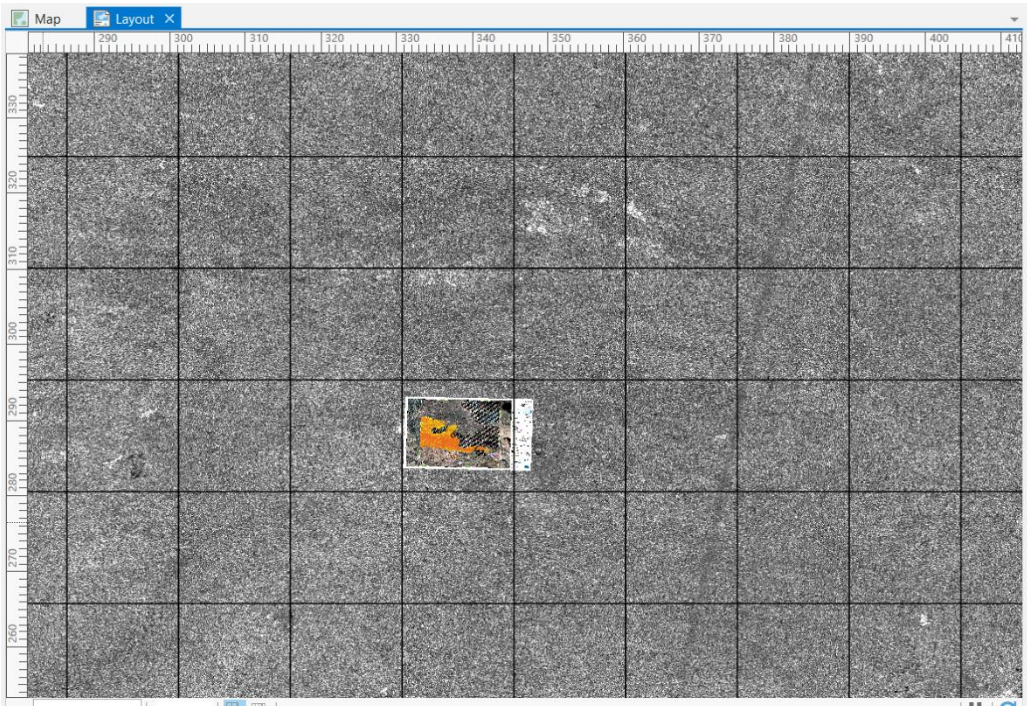
VV Polarization



Question 8) Evaluate your results from the VV and VH polarizations with respect to the Copernicus result. Which polarization showed the burned area? Describe your findings.



Forest fire detected in grid 330-280



Forest fire confirmed in grid 330-280 by overlaying the Copernicus Data

It is very clear from the images that VH polarization shows the area brighter and with sharper boundaries than the VV polarization, **making it easier to demarcate the burned area in VH polarization.**

These images were overlain by the Copernicus data to confirm the site of forest fire. The forest fire was detected in grid 330-280 in VH polarization which was confirmed to be at that location by Copernicus Data.

The visual comparison clearly highlights that VH polarization tend to exhibit a higher contrast between burned and unburned areas. Thus, it can be concluded that Cross Polarization is better for detecting forest fires and is recommended for the study purpose.