HOMEWORK 3

PREPARED BY

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STUDENT NUMBER : 010180617

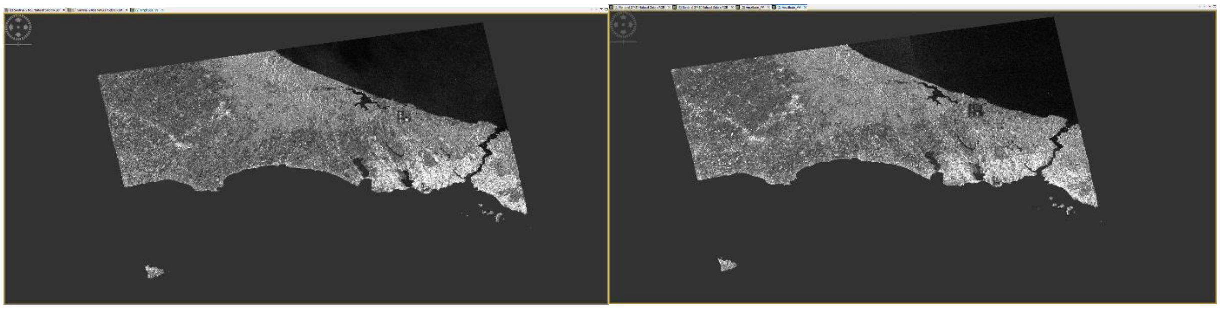
DUE DATE : 24/05/2023

COURSE NAME : REMOTE SENSİNG II

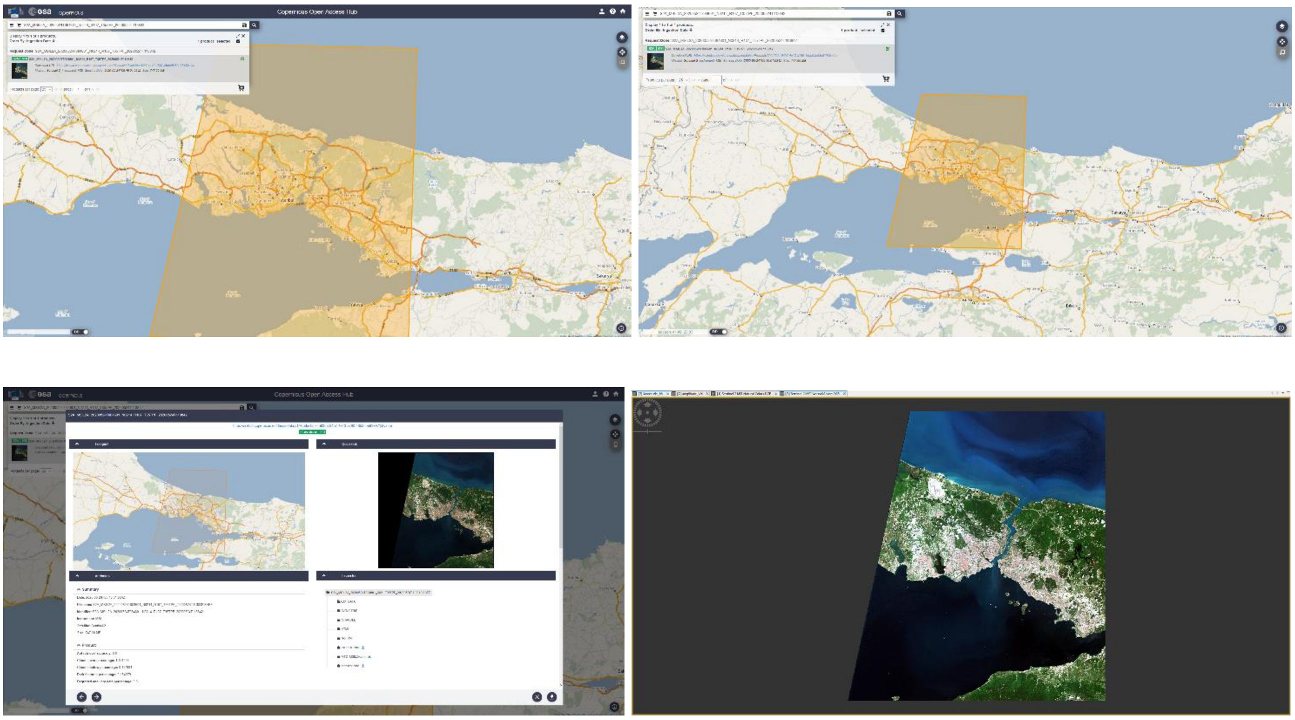
LECTURER : PROF.DR. ESRA ERTEN

Downloading Data

Sentinel 1 SAR image downloaded using the Google Drive link provided to you in NINOVA (Subset1_TC.tif).

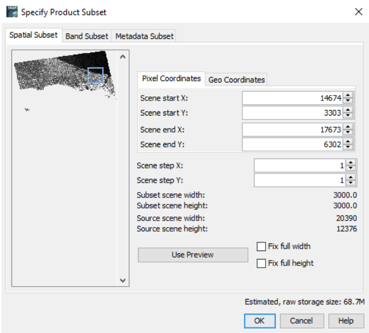


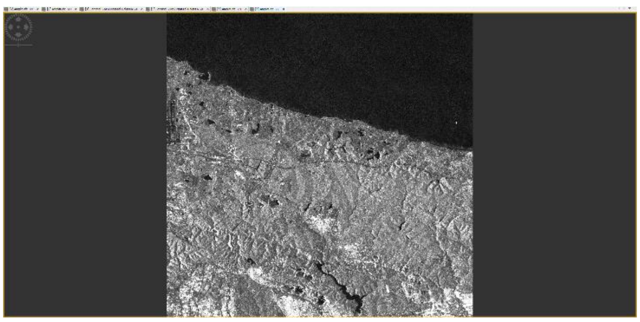
Sentinel 2 MSI image 22 May 2020 was downloaded from “https://scihub.copernicus.eu” website. Product Name is “S2A_MSIL2A_20200524T084601_N0214_R107_T35TPF_20200524T113842”.

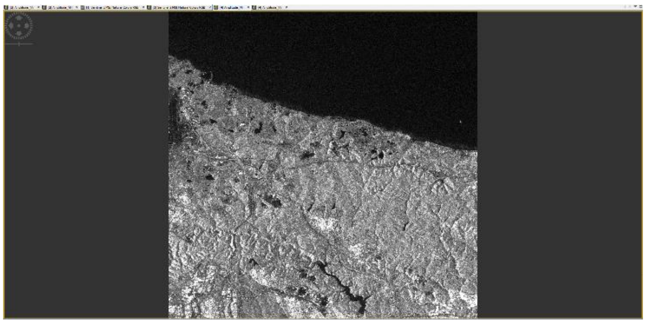


1) Sentinel 1 SAR Image Subsetting

According to the data in the Excel file uploaded with the homework file, the data belonging to us has been downloaded and the "R" region belonging to us has been 3000 x 3000 pixels subseted ESA Snap Software to the mark specified in the same file.

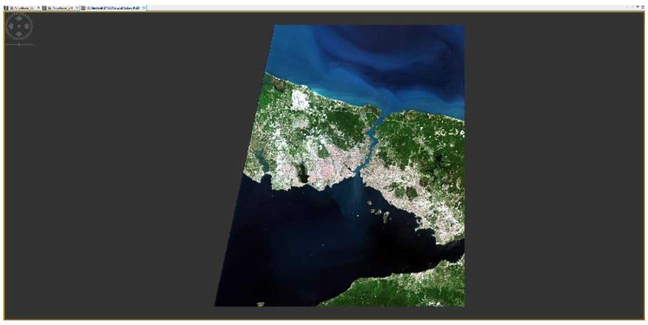


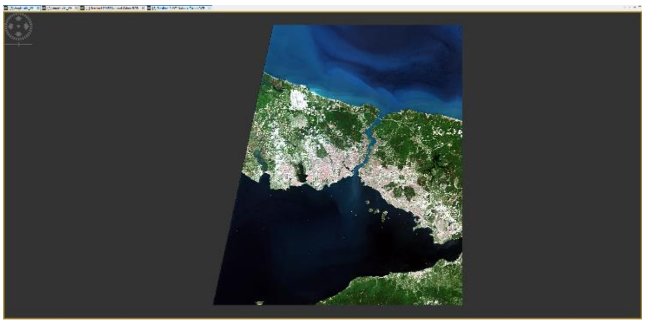




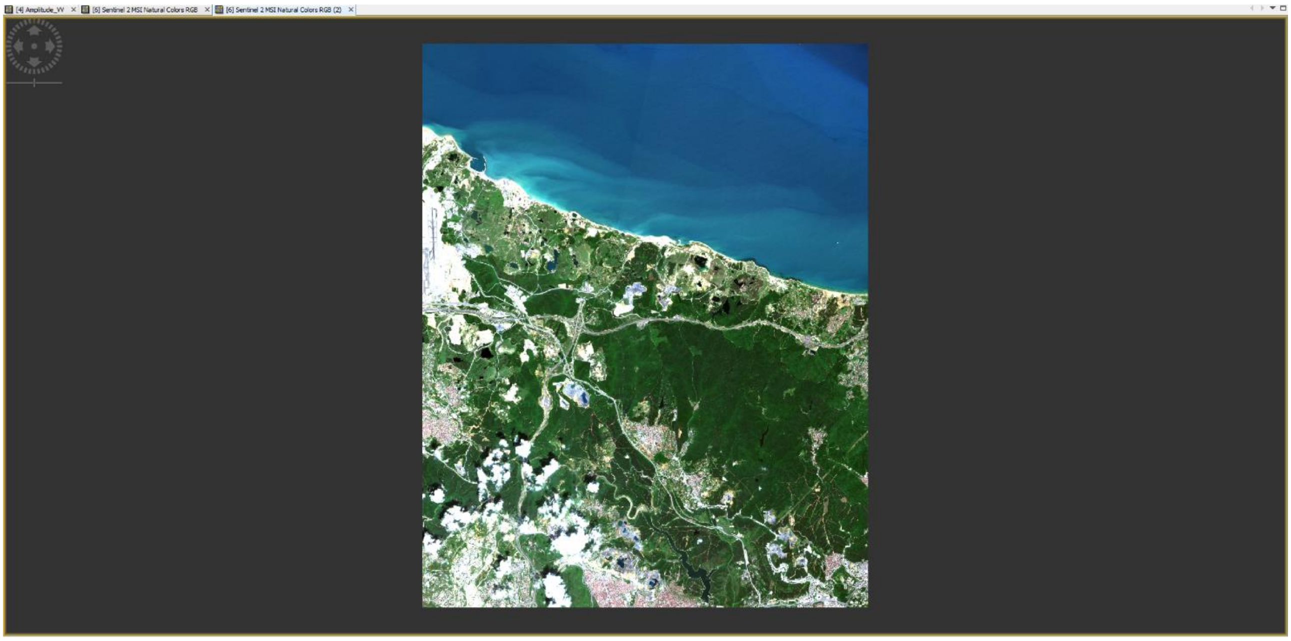
Resampling

Sentinel 2 image has been applied with the image to be able to open and subset via ESA Snap Software. The image with the Resample applied is the image on the right.



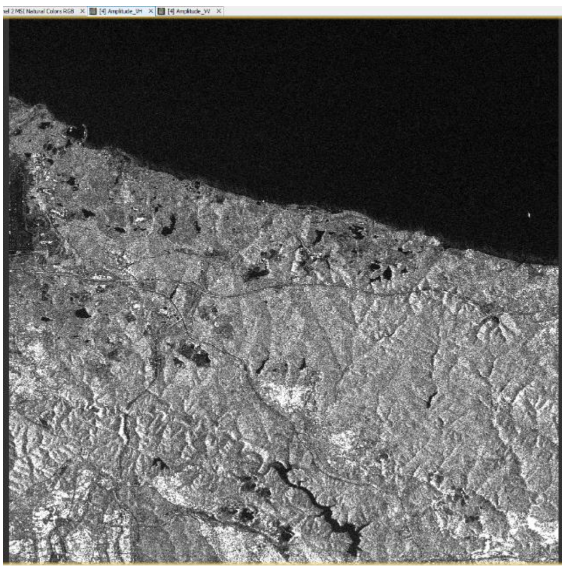


Then, the resampled Sentinel 2 image is subset according to the Geo Coordinates data of the Sentinel 2 SAR.

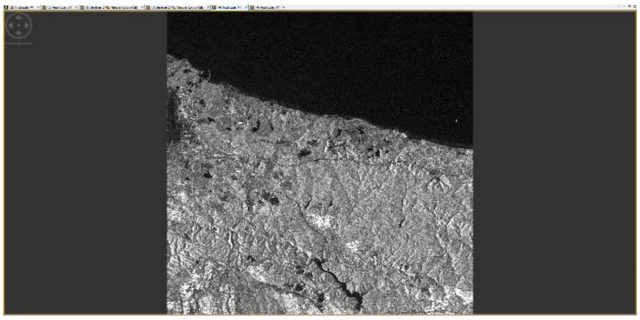
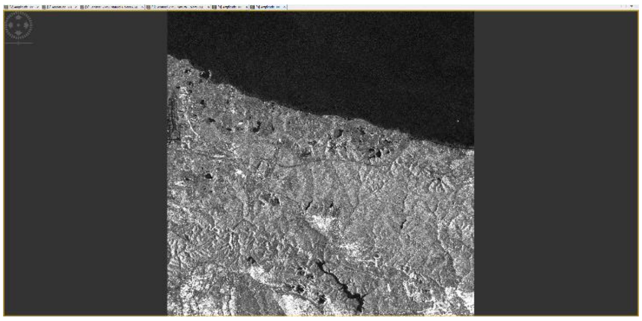


2) Visual Comparison of Sentinel 1 SAR and Sentinel 2 MSI Optical Images

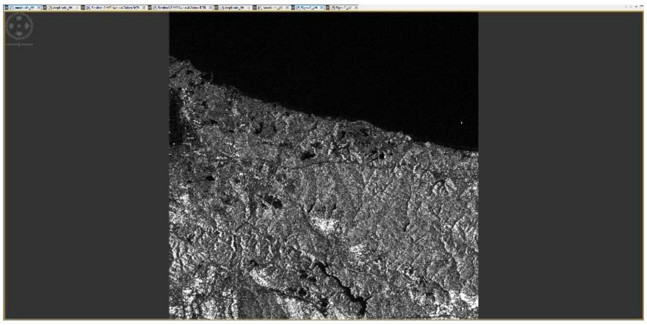
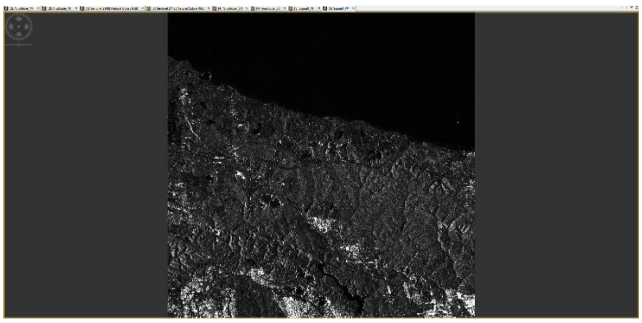
When we look at these two images, height differences and wetlands are clearly visible in Sentinel 1 SAR, while urban areas are more prominent due to color differences in Sentinel 2 MSI Optic image.



3) Radiometric Calibration of the SAR Image

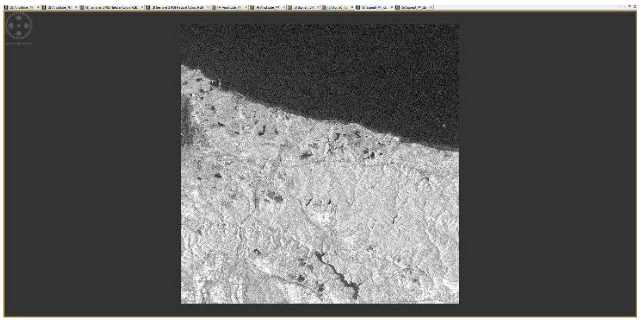



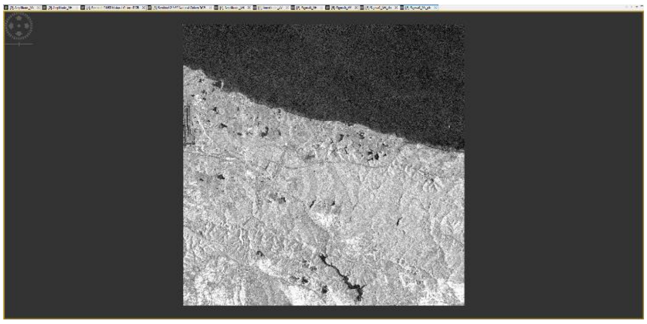
Radiometric calibration is very important in the analysis of SAR (Synthetic Aperture Radar) data collected by the satellite. In Sentinel-1 satellite images, the strength, or "amplitude," of radar waves reflected from Earth's surfaces varies depending on the surface properties. However, the amplitude values in raw satellite data are affected by factors such as the orbital position of the satellite, the geometry of the surface the sensor is scanning, and the atmospheric conditions in which the radar waves travel. Therefore, in order to correctly interpret real earth features, it is necessary to correct for these effects. Radiometric calibration provides this correction. After calibration, the resulting images represent surface properties more accurately and consistently, which is crucial for a variety of scientific and application-based analyses.

Linear to / from dB Conversation

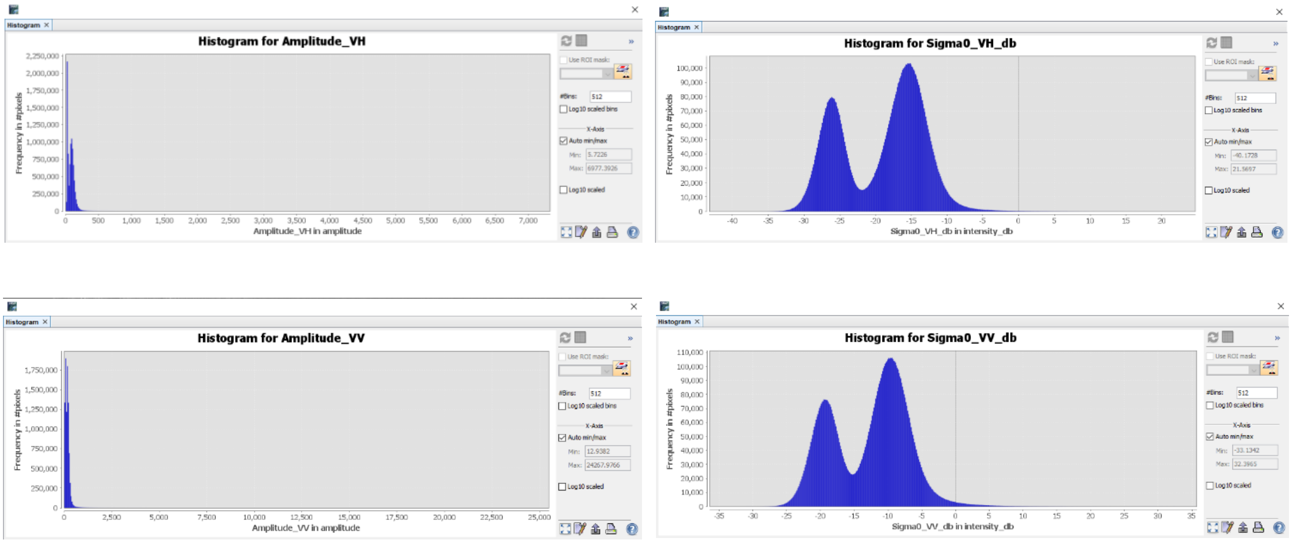
After radiometric calibration of Sentinel-1 SAR data, a "linear to dB" (decibel) conversion is usually made. The reason for applying this transformation is that radar data usually has a very wide dynamic range and this wide range is difficult to visualize and manipulate. The decibel scale compresses this wide range into a logarithmic scale, making smaller changes more obvious and overall data analysis easier. This transformation also better satisfies the statistical properties of radar data; The decibel scale often better expresses the multiplicative nature of the speckle noise of radar data. Therefore, the "linear to dB" conversion makes the analysis and visualization of Sentinel-1 data more convenient and effective.





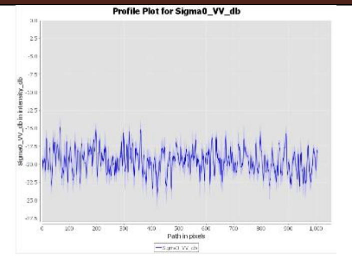
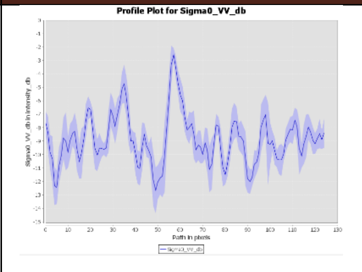
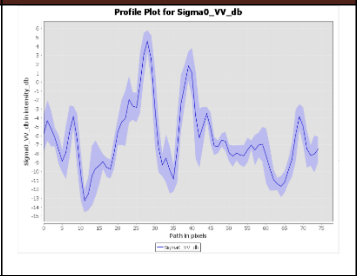
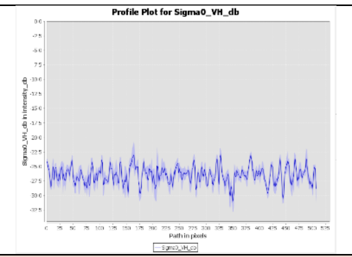
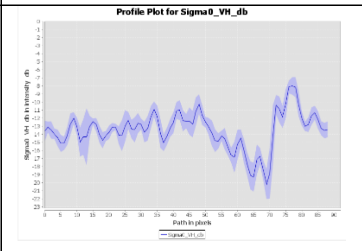
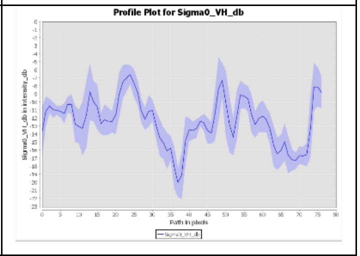
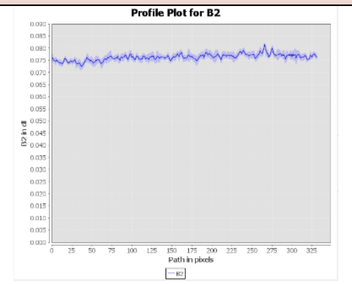
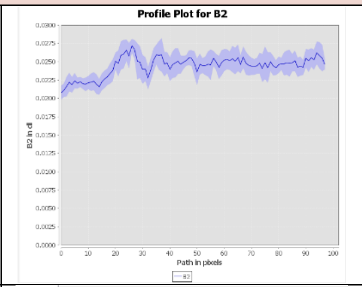
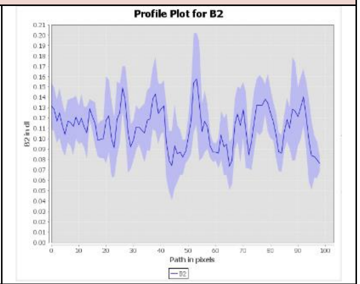
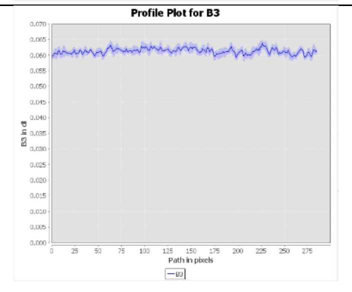
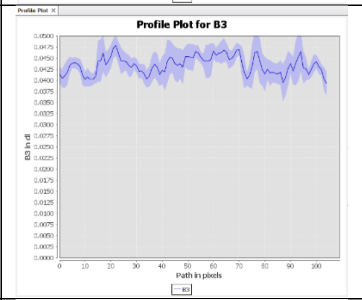
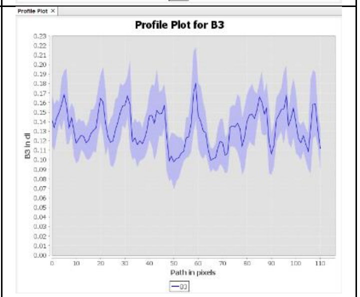
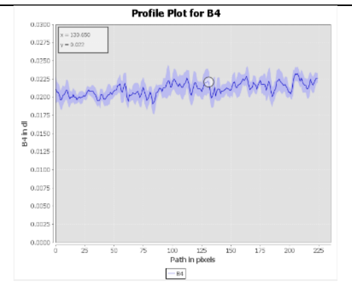
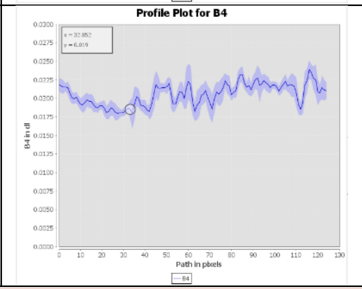
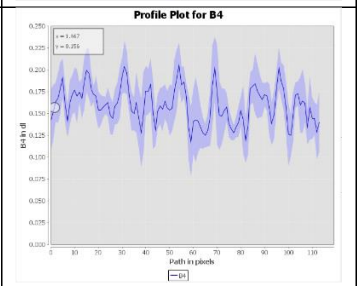
Comparison of Image Histograms

Looking at the histograms below, looking at the amplitude data without decibel translation, the histogram is much less clear and looks cluttered. On the other hand, in decibel-converted histograms, the histogram is much more understandable and spread out. When we compare them with each other, the value range of the VH histogram is (-35) - (-5), while the value range of the VV histogram appears to be (-25) - (5). In line with this information, the importance of the decibel translation step mentioned in the above paragraph has been proven in terms of clarity.



Comparison of the Points to be Selected on the Optical Image and the SAR Image

Points #	Coordinates		LULC Class	SAR(db)		Reflectance Values in the Optical Data			
	Lon.	Lat.		V V	V H	B	G	R	NIR
1	28.758414	41.184644	Urban Areas	0.22511445	0.06320812	0.0964	0.1214	0.1698	0.2408
2	28.829479	41.261810	Wet Lands	0.007825594	0.0030075547	0.054	0.0504	0.0142	0.0001
3	28.931403	41.212586	Forest	0.14015523	0.031552553	0.0248	0.0427	0.0223	0.5724
4	28.903576	41.334646	Water	0.00903474	0.0029444045	0.0743	0.0565	0.0172	0.012
5	28.828220	41.238050	Road	0.06719331	0.0169559	0.0979	0.1018	0.1104	0.1428

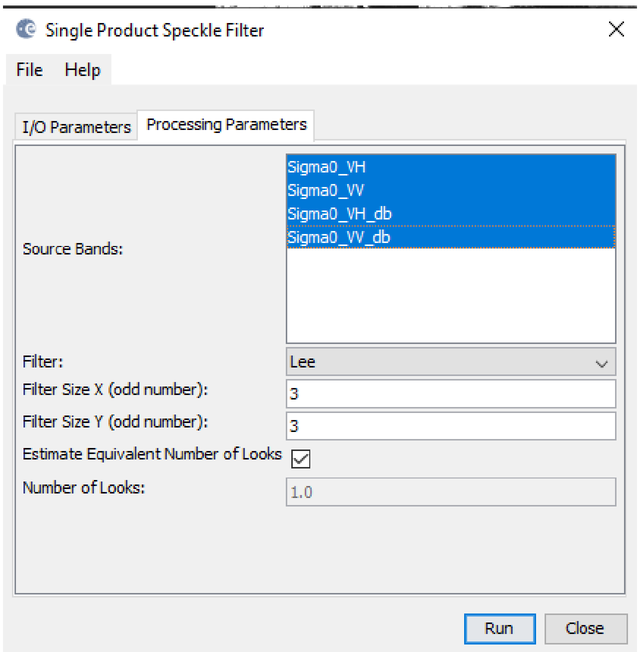
<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">LULC Class</th></tr>
<tr><th>Water</th><th>Forest</th><th>Urban Areas</th></tr>
<tr><td rowspan="2">SAR (db)</td><td>V V</td><td></td><td></td><td></td></tr>
<tr><td>V H</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">When we examine the profile plots of the SAR data, we can say that every earth feature has a suitable graphic.</td></tr>
<tr><td rowspan="3">Optical Data</td><td>B2</td><td></td><td></td><td></td></tr>
<tr><td>B3</td><td></td><td></td><td></td></tr>
<tr><td>B4</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Profile plots are shown over water, forest and urban areas, which are 3 different earth features, on Blue (B2), Green (B3), Red (B4) from optical data. When we examine these data, generally consistent graphs have emerged. The graph with the least fluctuation is water, the graph with the most fluctuations is the urban area, and this proves that we have drawn correct graphs.</td></tr>
</table>

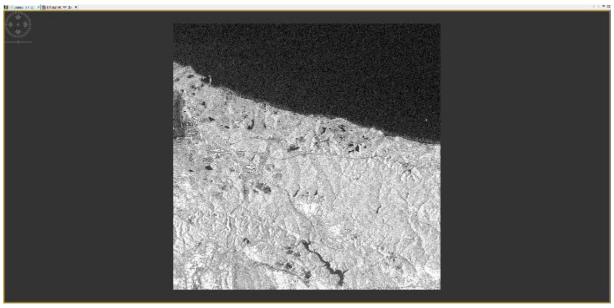
4) Speckle Reduction (Removal)

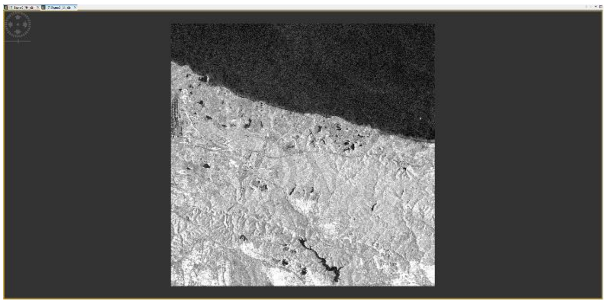
Speckle are variations of the random, salt-and-pepper appearance that are characteristic of Synthetic Aperture Radar (SAR) images, often referred to as "noise." This is due to the complex nature of the reflection of radar waves from the surface. Speckle can complicate the interpretation and analysis of SAR images because it can mask surface features and degrade image quality.

For this reason, speckle reduction or removal is usually applied to Sentinel-1 data. This process, usually using a filter, reduces random changes to the image and thus improves the overall quality of the image. This makes surface features appear clearer and helps analyzes yield more accurate results.

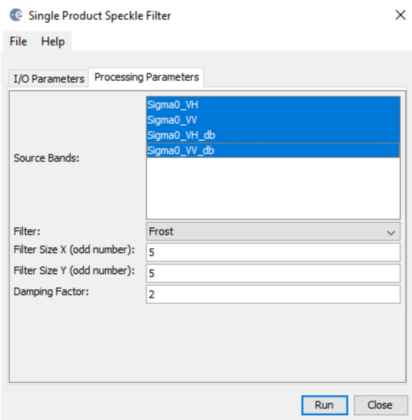
However, speckle reduction should be done with care. Excessive filtering can also destroy important information in the image. Therefore, the filtering process should be carefully selected and applied in accordance with the purpose and requirements of the analysis.

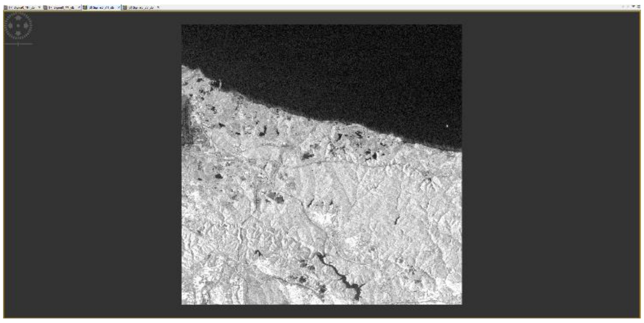


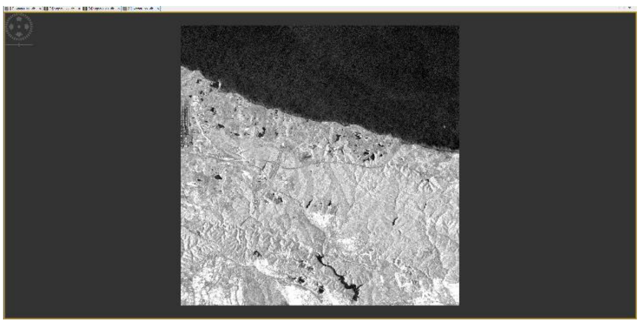


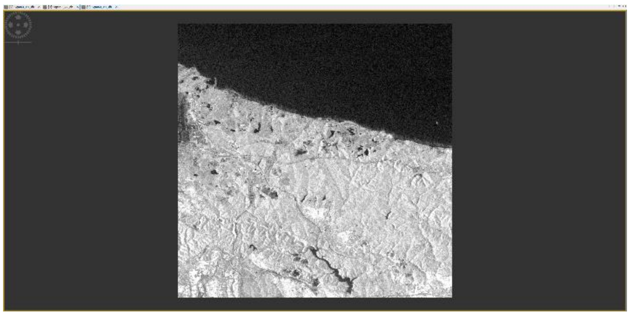


The 3x3 Lee filter works by using a 3x3 pixel floating window. This filter estimates the new value of each pixel by calculating the variance and mean of the peripheral pixels. This smaller window provides less noise reduction but also preserves image details. The two images above show this and the left VH is the right VV data. The 5x5 Frost filter, on the other hand, uses a 5x5 pixel sized floating window. The Frost filter uses an exponential correction factor to preserve image detail while reducing speckle. This larger window provides stronger noise reduction but can potentially blur more image details. The two images below illustrate this, and the left VH is the right VV data.

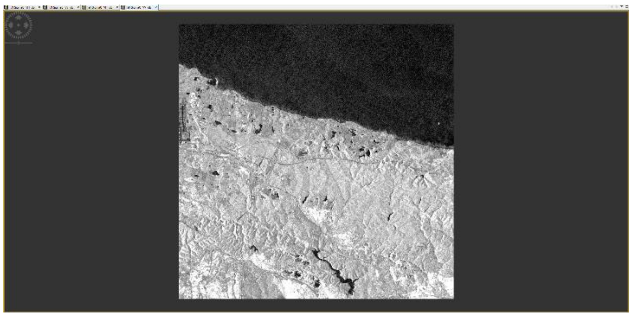




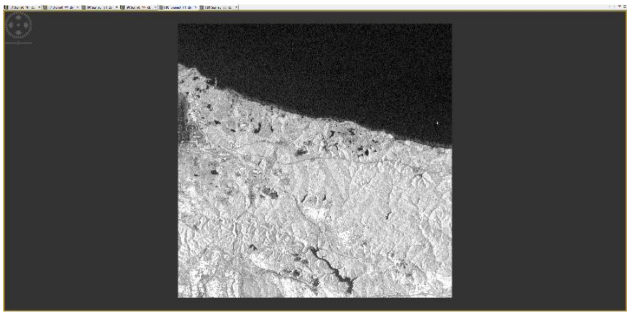




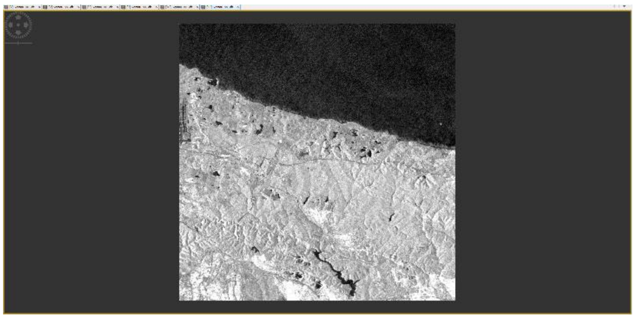
Lee 5x5 VH_db



Lee 5x5 VV_db



Frost 3x3 VH_db



Frost 3x3 VV_db

5) Supervised Image Classification

Supervised classification is a machine learning technology that is widely used in the analysis of satellite images and other types of data. In this method, the algorithm "learns" to use the input data to predict the output. The learning process takes place "supervised" with a pre-labeled training data set. For example, if you are trying to determine what type of terrain (eg water, forest, farmland, etc.) a particular pixel is in a satellite image, labeled samples of the same type are used to train the algorithm. The algorithm learns from this training data and can then classify other pixels in the image.

Supervised classification can often achieve high accuracy rates, but keep in mind that quality, labeled training data must be available. This method is used in many applications such as determining land cover and use in the analysis of satellite images.

We applied supervised classification of our Lee 3x3 data, which we chose as the most understandable among the images we filtered. We arranged the labels that emerged as a result of this classifiaction in the appropriate colors.