REMOTE SENSING II HOMEWORK 3

PREPARED BY

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COURSE NAME : REMOTE SENSING II

LECTURER : PROF. DR. ESRA ERTEN

Data Set Attribute	*Attribute Value*	*Data Set Attribute*	*Attribute Value*
Satellite ID	Landast 5	Image acquisition date and time	2007/06/06
Sensor ID	TM	Image Path number	180
Image Scene ID	LT51800312005157MTI00	Image Row number	031
Image Product ID	LT05_L1TP_180031_20050606_20200902_02_T1	Image quality	9
Sun elevation	63.29149694	Sun azimuth	128.65785632
Land Cloud Cover	1.00	Scene Cloud Cover	1.00
Corner Upper Left Latitude	42.70394	Corner Upper Left Longitude	28.24930
Corner Upper Right Latitude	42.38177	Corner Upper Right Longitude	30.45888
Corner Lower Left Latitude	41.12716	Corner Lower Left Longitude	27.75566
Corner Lower Right Latitude	40.81262	Corner Lower Right Longitude	29.91411
Corner Upper Left Lat DMS	42°42'14.18"N	Corner Upper Left Long DMS	28°14'57.48"E
Corner Upper Right Lat DMS	42°22'54.37"N	Corner Upper Right Long DMS	30°27'31.97"E
Corner Lower Left Lat DMS	41°07'37.78"N	Corner Lower Left Long DMS	27°45'20.38"E
Corner Lower Right Lat DMS	40°48'45.43"N	Corner Lower Right Long DMS	29°54'50.80"E

Table 1 Metadata table from of image from Landsat 5 TM Level 1 satellite

Table 1 is containing the metadata of my workspace area image at "*https://earthexplorer.usgs.gov*".

Image 1 Image of Landsat 5 TM Level 1 satellite with 180 Path and 31 Raw numbers dated May 11, 2007.

Figure 1 is the preview image of my workspace on "https://earthexplorer.usgs.gov/".

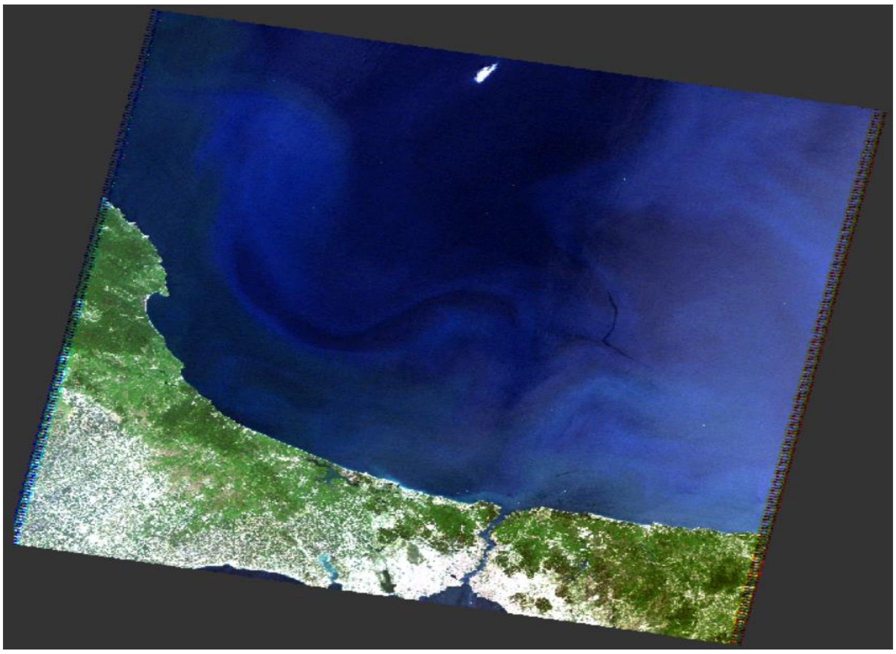

Image 2 Image that opened with SNAP program.

Image 3 Subset Image

FOR SIMPLE INDEXES NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

The Landsat 5 Normalized Difference Vegetation Index (NDVI) is a remote sensing technique for determining the amount of live green vegetation in a given area. The NDVI is calculated from the spectral reflectance of vegetation, which is captured by the sensors on the Landsat 5 satellite in two wavelength ranges: the red and near-infrared regions of the electromagnetic spectrum.

The formula for calculating NDVI is:

NDVI = (NIR - Red) / (NIR + Red)

It is important to remember that Landsat 5 was superseded by more recent satellites, namely Landsat 8, that offer better resolution, spectrum coverage, and data quality. Landsat 8 also collects NDVI data. Yet the historical Landsat 5 NDVI data continues to be a useful tool for long-term monitoring and trend analysis of plant cover.

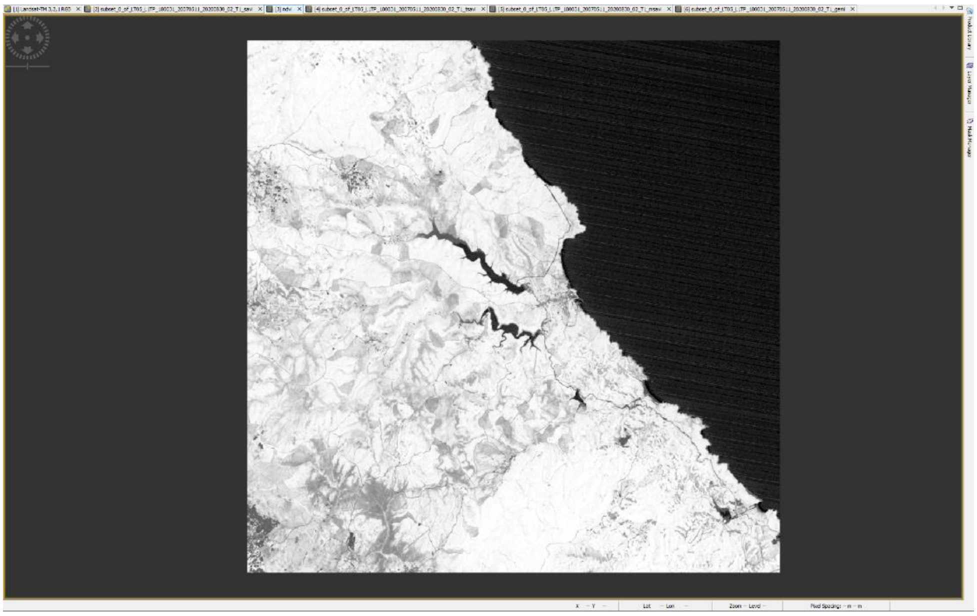

Image 4 Normalized Difference Vegetation Index Image

FOR INDEXES WHICH USE A SOIL AND LINE SOIL ADJUSTED VEGETATION INDEX (SAVI)

The Landsat 5 Soil Adjusted Vegetation Index (SAVI) and Line Soil Adjusted Vegetation Index (LSAVI) are remote sensing techniques that assess vegetation health while taking soil background effects into account. These indices were created to lessen the impact of soil reflectance on vegetation indices, especially in areas with sparse vegetation or in dry or arid regions.

The spectral reflectance of vegetation and the soil background, which is recorded by the Landsat 5 satellite's sensors in the red and near-infrared portions of the electromagnetic spectrum, is used to calculate SAVI and LSAVI. Similar to NDVI, SAVI and LSAVI also include a soil adjustment factor to take into consideration the amount of bare soil in the image.

The formula for calculating SAVI is:

SAVI = ((NIR - Red)/(NIR + Red + L)) x (1 + L)

Where NIR is the spectral reflectance in the near-infrared region, Red is the spectral reflectance in the red region, and L is the soil adjustment factor, which ranges from 0 to 1 and is determined by the proportion of bare soil in the image.

The formula for calculating LSAVI is:

LSAVI = ((1 + L) x (NIR - Red))/(NIR + Red + L)

Many applications, including crop monitoring, land use planning, and environmental management, use SAVI and LSAVI. It is important to remember that Landsat 5 was retired in 2013 and was replaced by newer satellites like Landsat 8, which also collect SAVI and LSAVI data and offer better resolution, spectral coverage, and data quality.

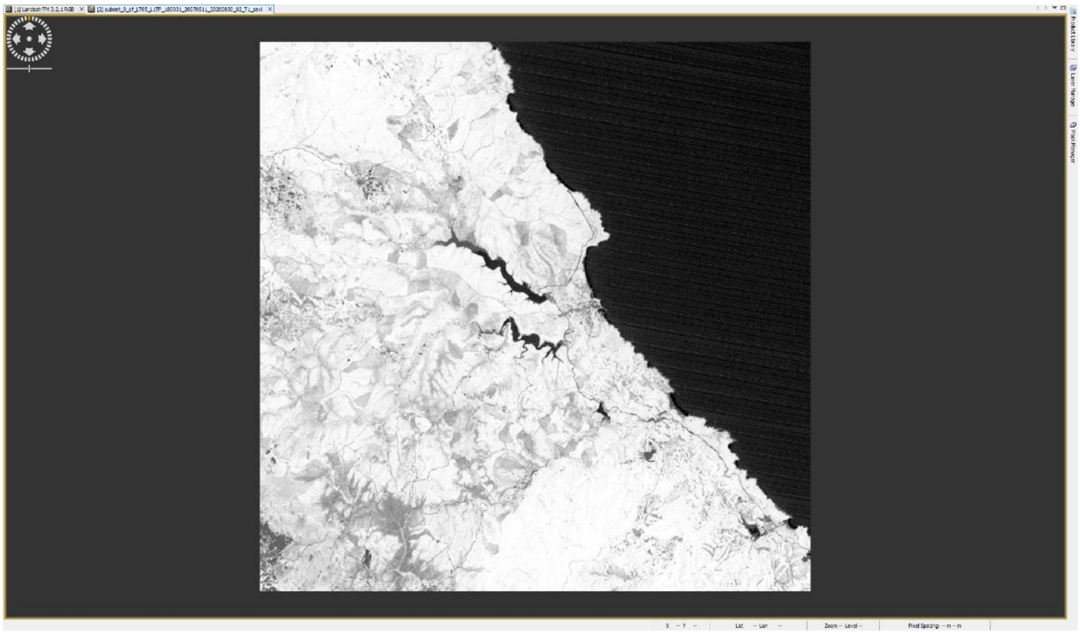

Image 5 Soil Adjusted Vegetation Index Image

TRANSFORMED SOIL ADJUSTED VEGETATION INDEX (TSAVI)

Using remote sensing, the Transformed Soil Adjusted Vegetation Index (TSAVI) analyzes vegetation health while taking soil background effects into consideration. By lowering the noise in the vegetation index data and boosting the contrast between vegetation and soil in photographs, the TSAVI was created to outperform the Soil Adjusted Vegetation Index (SAVI) and the Line Soil Adjusted Vegetation Index (LSAVI).

The spectral reflectance of vegetation and the soil background, which is recorded by Landsat 5's sensors in the red and near-infrared spectrum, is used to calculate TSAVI. The transformation factor in TSAVI modifies the index to improve the contrast in photographs between vegetation and soil.

The formula for calculating TSAVI is:

TSAVI = ((NIR - Red) / (NIR + Red + 0.5)) x (1.5 - ((2 * (NIR - Red) + 1)^2 - 8 * (NIR - Red))^(0.5) / 2)

Applications like vegetation monitoring, land use planning, and environmental management have all made use of TSAVI. This is the data chosen for use in homework. The reason is this index, which is the most suitable for the 4 Level Density Slicing Method as a histogram, although it is not the most suitable or the most distinguishable one as an image. However it's important to remember that Landsat 5 was retired in 2013 and was replaced by more recent satellites, such Landsat 8, which also record TSAVI data and provide better resolution, spectrum coverage, and data quality.

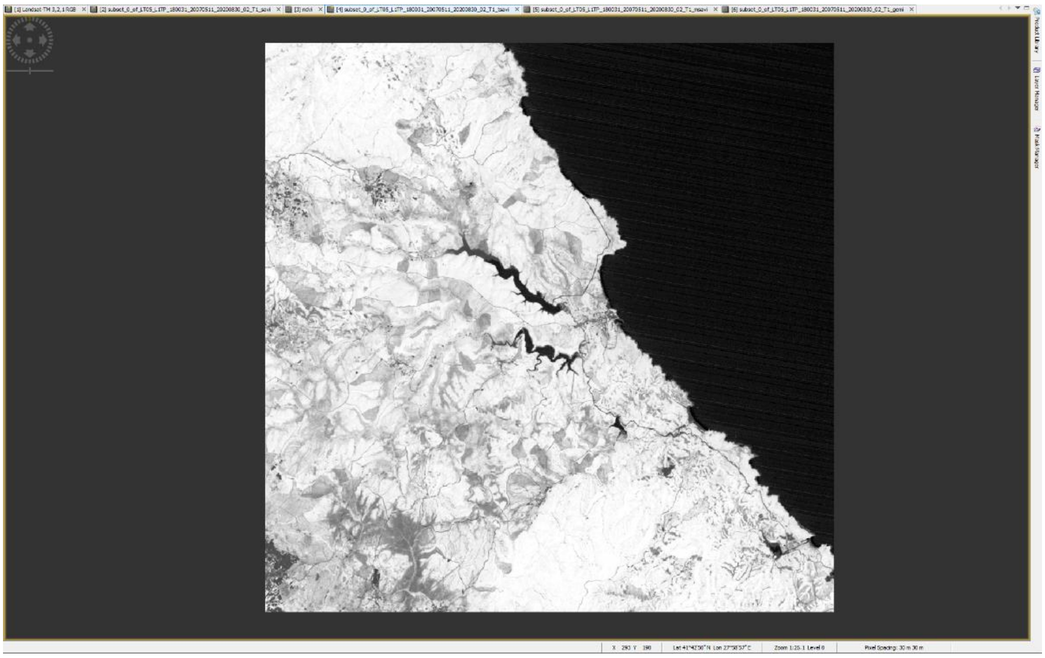

Image 6 Transformed Soil Adjusted Vegetation Index Image

MODIFIED SOIL ADJUSTED VEGETATION INDEX (MSAVI)

The Modified Soil Adjusted Vegetation Index (MSAVI) is a remote sensing technique that accounts for soil background effects when measuring vegetation health. The MSAVI was created to improve on the SAVI and LSAVI by reducing noise in the vegetation index data and providing a simpler calculation formula.

The spectral reflectance of soil background and vegetation, which is measured by the Landsat 5 satellite's sensors in the red and near-infrared spectrum, is used to calculate MSAVI. MSAVI has a modification factor that modifies the index to lessen data noise.

The formula for calculating MSAVI is:

MSAVI = ((2 * NIR + 1) - (((2 * NIR + 1)^2 - 8 * (NIR - Red))^(0.5))) / 2

Applications including land use planning, vegetation monitoring, and environmental management have all employed MSAVI. The fact that Landsat 5 was retired in 2013 and replaced by more recent satellites, such Landsat 8, which similarly record MSAVI data and provide better resolution, spectrum coverage, and data quality, should be noted.

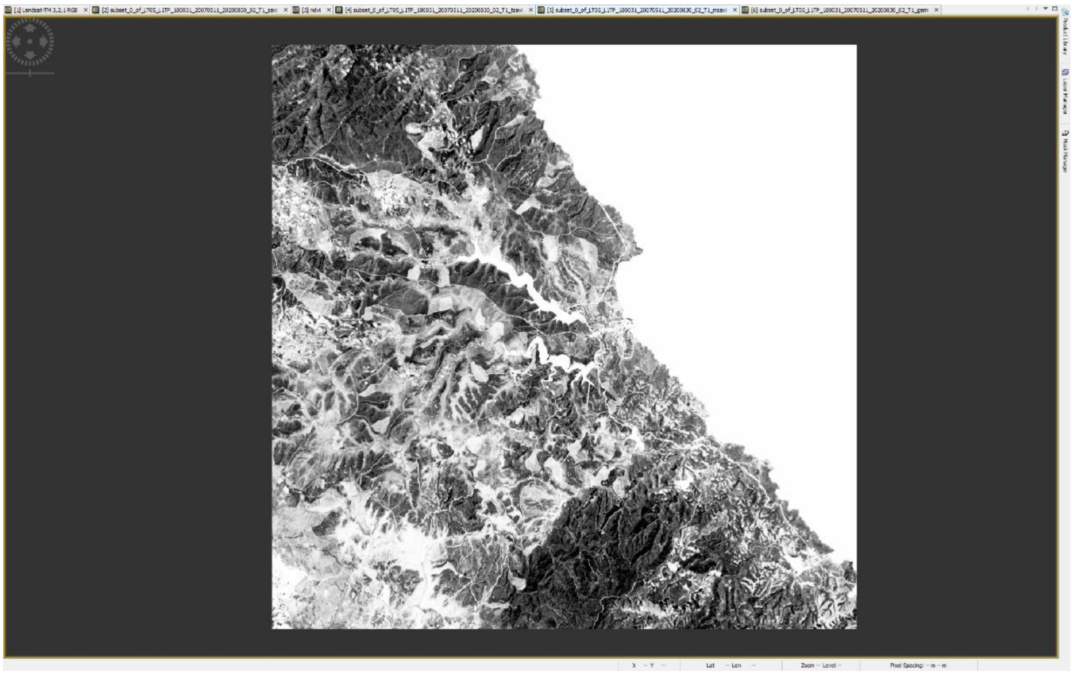

Image 7 Modified Soil Adjusted Vegetation Index Image

FOR ATMOSPHERICALLY CORRECTED INDEXES GLOBAL ENVIRONMENTAL MONITORING INDEX (GEMI)

The Global Environmental Monitoring Index (GEMI) is a remote sensing technique that measures vegetation health and reflects changes in the environment over time. The GEMI was created to reduce the noise in vegetation index data that is caused by changes in atmospheric and soil conditions.

The Landsat 5 satellite's sensors record the spectral reflectance of vegetation and the soil backdrop in the blue, green, and red portions of the electromagnetic spectrum. GEMI is derived from these data. GEMI has a correction component that modifies the index to lessen noise brought on by soil and atmospheric fluctuations.

The formula for calculating GEMI is:

GEMI = ((2 * ((NIR^2 - Red^2) + (0.5 * NIR) + (0.5 * Red))) / ((NIR + Red + 0.5) * (1 + 0.25) - (1.5 * (NIR^2 - Red^2) - (0.5 * NIR) - (0.5 * Red))^(0.5)))

Applications including vegetation monitoring, land use planning, and environmental management have all made use of GEMI. However, it is important to keep in mind that Landsat 5 was retired in 2013 and was replaced by more recent satellites, such Landsat 8, which also collect GEMI data and have better resolution, spectrum coverage, and data quality.

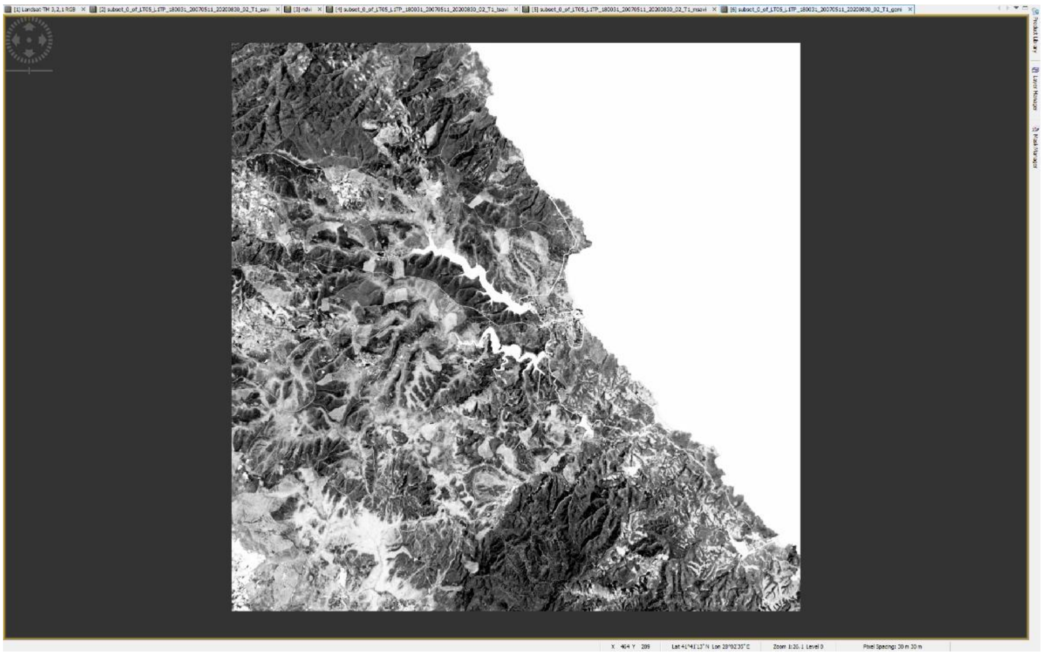

Image 8 Global Environmental Monitoring Index Image

COMPARISON OF THE INDEXES HISTOGRAM

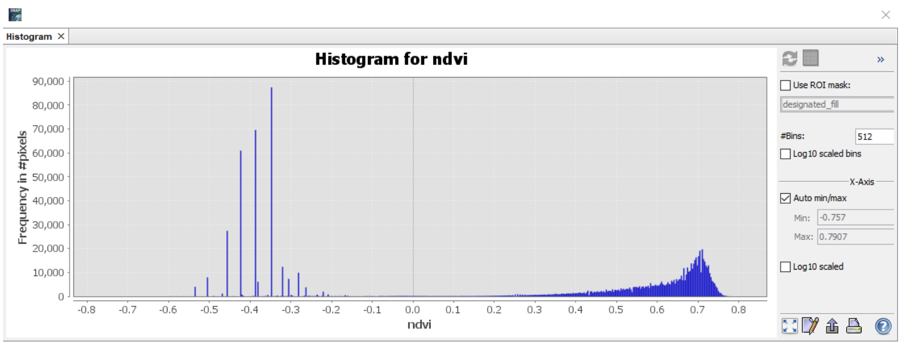

Image 9 Normalized Difference Vegetation Index Histogram

Spectral reflectance in the near-infrared range is denoted by NIR, whereas spectral reflectance in the red range is denoted by Red. NDVI readings vary from -1 to 1, with readings closer to 1 indicating more live vegetation and readings closer to -1 indicating little to no live vegetation.

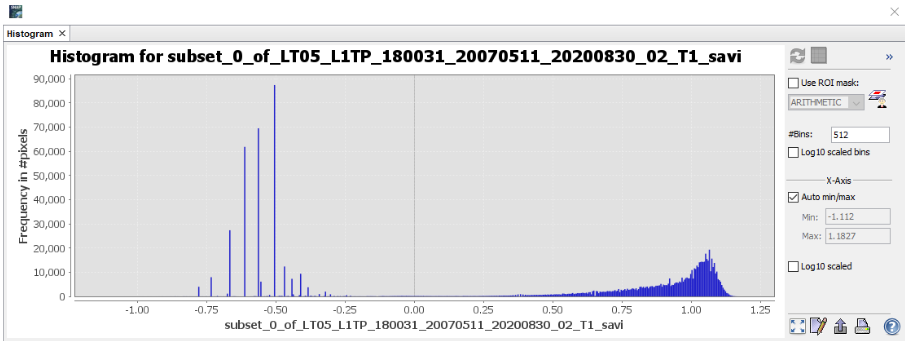

Image 10 Soil Adjusted Vegetation Index Histogram

Similar to NDVI, the range of SAVI and LSAVI values is -1 to 1, with values closer to 1 suggesting areas with more living vegetation and values closer to -1 indicating areas with little to no live vegetation.

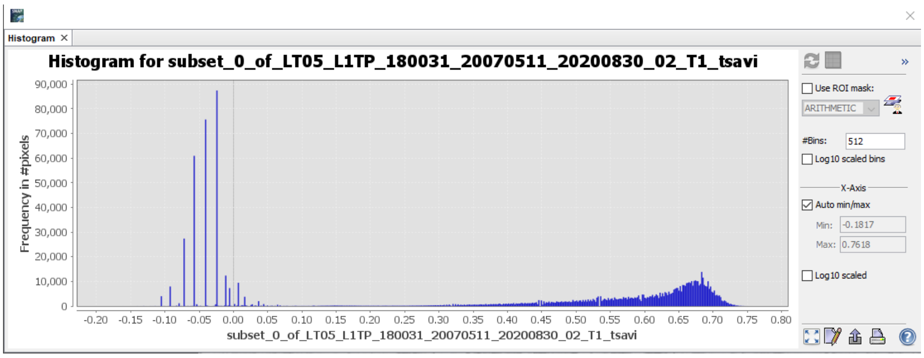

Image 11 Transformed Soil Adjusted Vegetation Index Histogram

The TSAVI values range from -1 to 1, just like the NDVI, SAVI, and LSAVI values, with values closer to 1 indicating areas with more living vegetation and values closer to -1 indicating areas with little to no live vegetation.

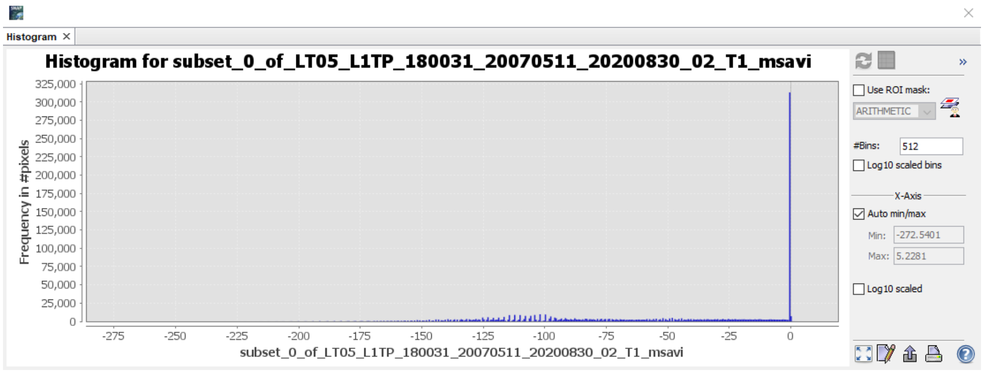

Image 12 Modified Soil Adjusted Vegetation Index Histogram

The values of MSAVI, like those of NDVI, SAVI, LSAVI, and TSAVI, vary from -1 to 1, with values closer to 1 denoting areas with more living vegetation and values closer to -1 denoting areas with little to no live vegetation.

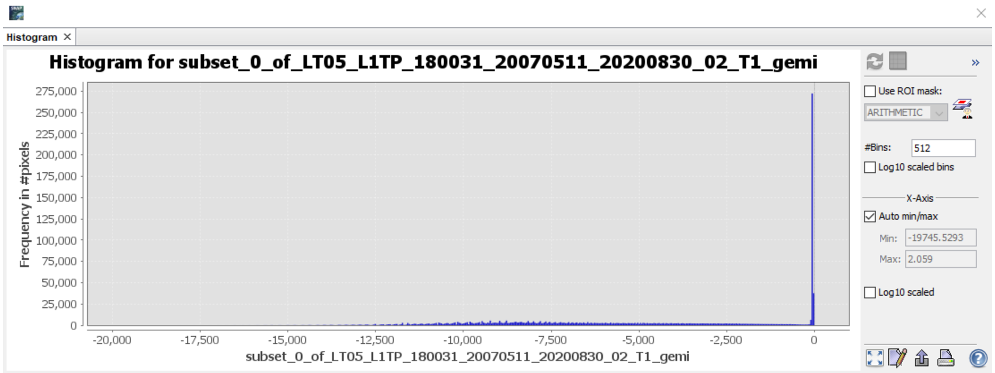

Image 13 Global Environmental Monitoring Index Histogram

GEMI values vary from -1 to 1, just like NDVI, SAVI, LSAVI, TSAVI, and MSAVI. Values closer to 1 indicate areas with more live vegetation, while values closer to -1 indicate areas with little to no live vegetation.

APPLAYING 4 LEVEL DENSITY SLICING METHOD

When we compared our data for the application of the 4 Level density slicing method, we decided that our most appropriate data was our TSAVI data, and the histograms starting from 0.00 and 0.20 are shown in zoomed form below.

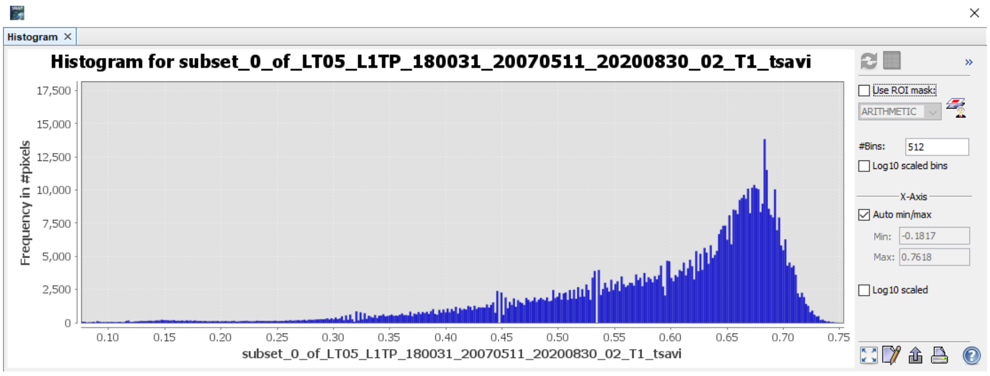

Image 14 Best Index (TSAVI) Zoom from 0.00

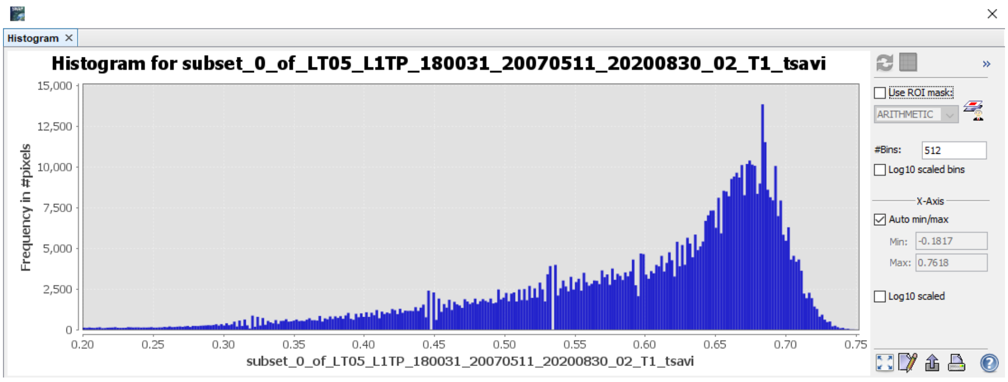

Image 15 Best Index (TSAVI) Zoom from 0.20

Mask Manager

	Name	Type	Colour	Tra...	Description
☐	ARITHME...	Maths		0.7	An arithmetic exception occurred.
☐	NEGATIVE	Maths		0.7	Index value is too low.
☐	SATURA...	Maths		0.7	Index value is too high.
☑	new_mas...	Range		0.5	0.0 <= subset_0_of_LT05_L1TP_180031_20070511_2020083...
☑	new_mas...	Range		0.5	0.35 <= subset_0_of_LT05_L1TP_180031_20070511_202008...
☑	new_mas...	Range		0.5	0.45 <= subset_0_of_LT05_L1TP_180031_20070511_202008...
☑	new_mas...	Range		0.5	0.55 <= subset_0_of_LT05_L1TP_180031_20070511_202008...
☑	new_mas...	Range		0.5	0.65 <= subset_0_of_LT05_L1TP_180031_20070511_202008...

Image 16 Mask Manager Before Readjustment

Mask Manager

	Name	Type	Colour	Tra...	Description
☐	ARITHME...	Maths		0.7	An arithmetic exception occurred.
☐	NEGATIVE	Maths		0.7	Index value is too low.
☐	SATURA...	Maths		0.7	Index value is too high.
☑	new_mas...	Range		0.5	0.0 <= subset_0_of_LT05_L1TP_180031_20070511_2020083...
☑	new_mas...	Range		0.5	0.35 <= subset_0_of_LT05_L1TP_180031_20070511_202008...
☑	new_mas...	Range		0.5	0.45 <= subset_0_of_LT05_L1TP_180031_20070511_202008...
☑	new_mas...	Range		0.5	0.55 <= subset_0_of_LT05_L1TP_180031_20070511_202008...
☑	new_mas...	Range		0.5	0.65 <= subset_0_of_LT05_L1TP_180031_20070511_202008...

Image 17 Mask Manager After Adjustment Made

First of all, after adjusting the Mask manager range and color settings in the 2 images above, our image has become as follows. As you can see, after this process, forest areas are dark green and grasslands are light green. Urban areas appear red and yellow, while soil and sand areas appear blue. As can be seen in the picture, blues were also encountered in the coastal parts of the lake and sea.

This is because the water is shallow or the amount of sand and soil mixed with the water is high. The remaining water areas are shown in black.

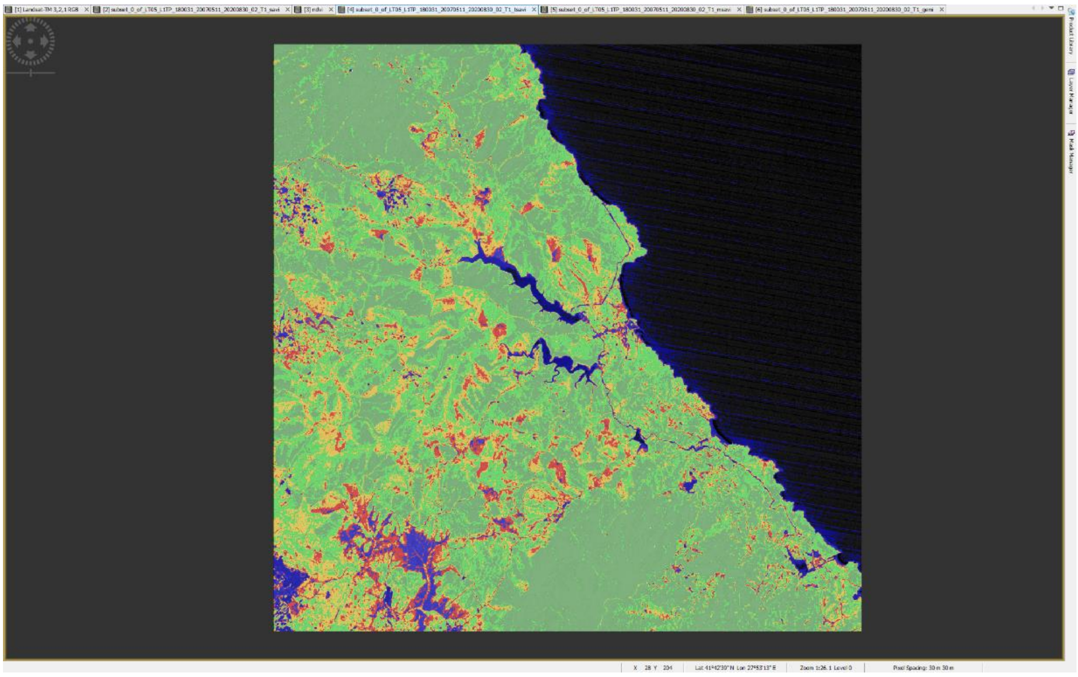

Image 18 TSAVI Image After Colour Adjusted

APPLYING NORMALIZED BUILT AREA INDEX

The Normalized Built-up Area Index (NBAI), which is used to identify and map urban areas, is one of the applications of Landsat 5 data. NBAI is a measurement of the amount of built-up area in a certain area that is determined using a combination of visible and near-infrared bands from satellite data.

The data must first be preprocessed to account for atmospheric effects and transform pixel values into reflectance values before NBAI can be applied to Landsat 5 imagery. The visible and near-infrared bands are then merged utilizing the following equation:

NBAI = (NIR - Red) / (NIR + Red) → As seen below image.

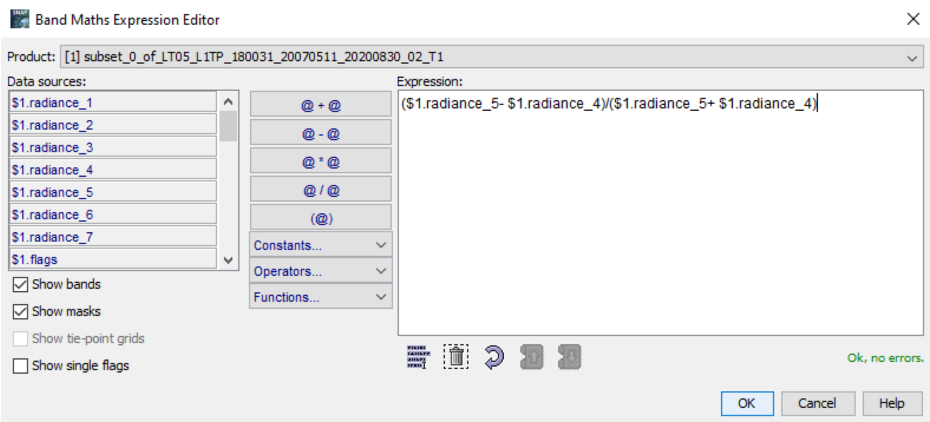

Image 19 NDBI Expression

Landsat 5 has been a valuable tool for monitoring and mapping urban areas with NBAI, and its data has been used for a variety of purposes, such as urban planning, environmental monitoring, and disaster management. Though its sensors are no longer in use, Landsat 5's official mission concluded in 2013. As a result of this application, as can be seen in the photo below, forest areas appear darker, urban areas, soil areas and roads appear lighter.

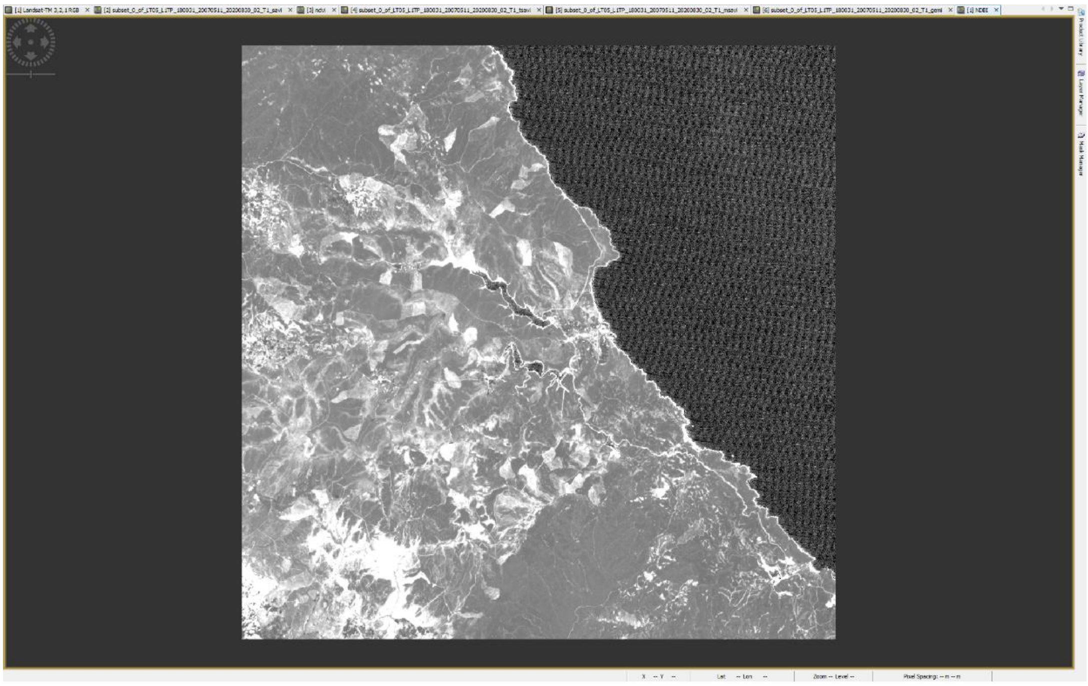

Image 20 NDBI Image

APPLAYING NORMALIZED DIFFRENCES WATER INDEX

The Normalized Difference Water Index (NDWI), which is used to map water bodies and track changes in water resources, is one of the applications of Landsat 5 data. The near-infrared (NIR) and green bands from satellite imaging are used to calculate NDWI, which gives a measurement of the amount of water in a certain area.

The data must first be preprocessed to account for atmospheric effects and convert the pixel values to reflectance values before NDWI can be applied to Landsat 5 imagery. The NDWI is then determined using the formula shown below:

NDWI = (NIR - Green) / (NIR + Green)

In conclusion, Landsat 5 has been a valuable tool for monitoring and mapping water resources using NDWI, and its data has been used in a variety of applications, such as hydrological modeling, drought monitoring, and water resource management.

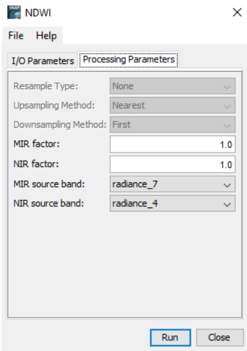

Image 21 NDWI Parameters

As a result of this application, it is easier to distinguish the areas with water, the areas with water appear tingling, while the forest areas, city centers and soil areas appear darker.

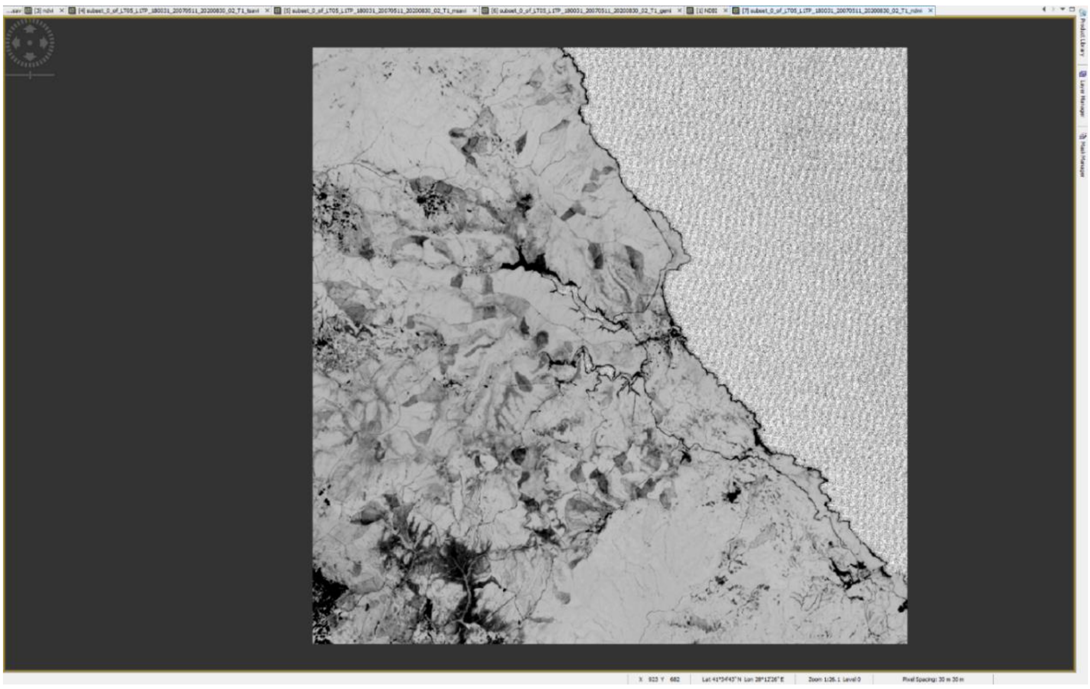

Image 22 NDWI Image

Conclusion

As a result, the use of spectral indices obtained from Landsat 5 data has proven to be an invaluable tool in remote sensing for a range of applications, including mapping land cover, monitoring vegetation, urban planning, and managing water resources. These indices, like the Normalized Built-up Area Index (NBAI) and the Normalized Difference Water Index (NDWI), make it possible to identify and map particular features on the Earth's surface, giving decision-makers in industries like forestry, agriculture, and natural resource management crucial data. Our knowledge of the Earth's ecology has greatly benefited from the use of spectral indices and Landsat 5 data, which have also laid the path for future developments in remote sensing technology.