
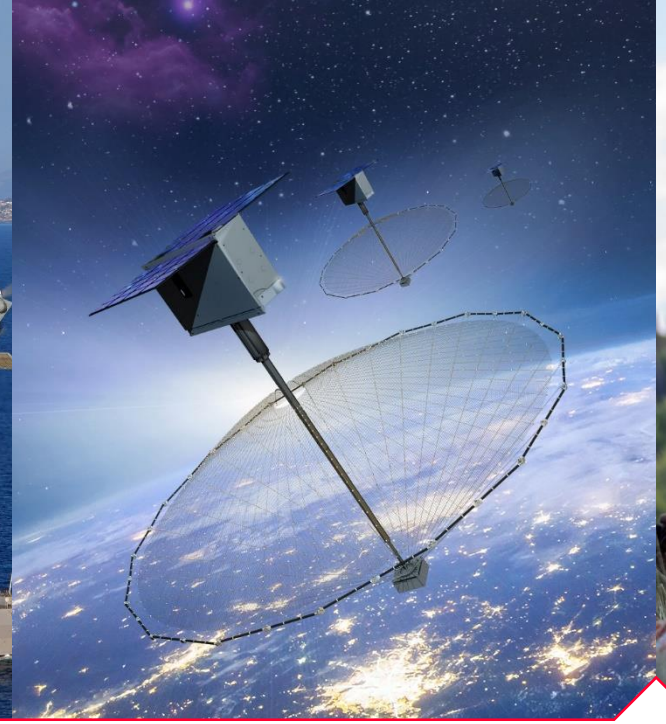
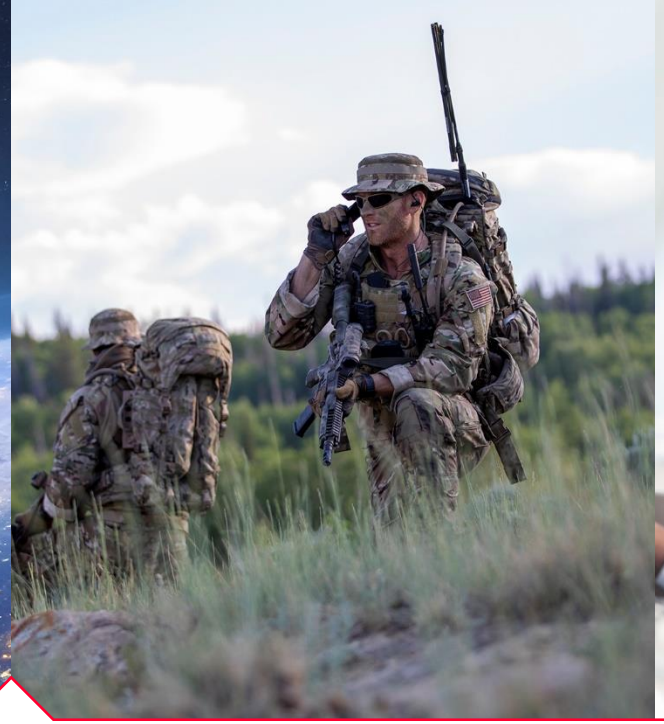


L3HARRIS™

APPLICATIONS AND ANSWERS WITH HIGH SPATIAL AND SPECTRAL RESOLUTION UAV IMAGERY

5/7/2020

Callum Scougal, Sales Engineer, MicaSense
Megan Gallagher, Solutions Engineer, L3Harris

Introductions

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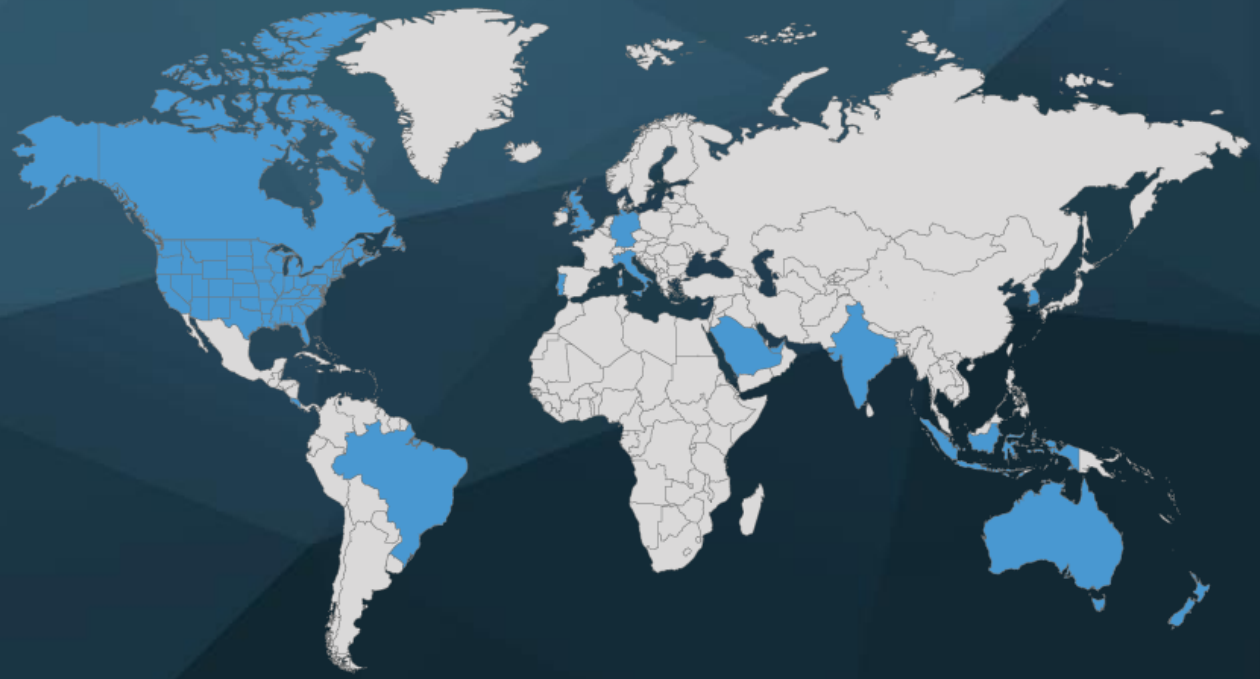
L3HARRIS

L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs.



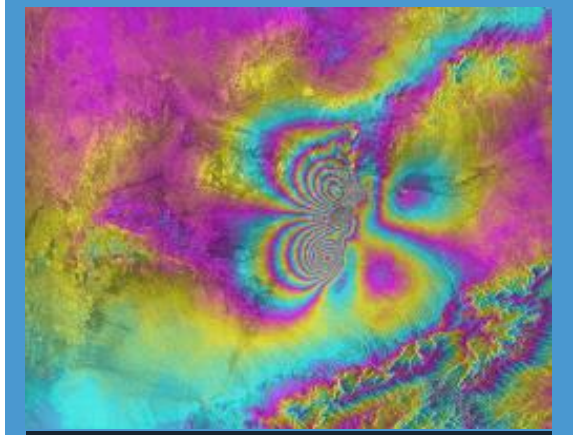
~400
LOCATIONS

CUSTOMERS IN
~130
COUNTRIES

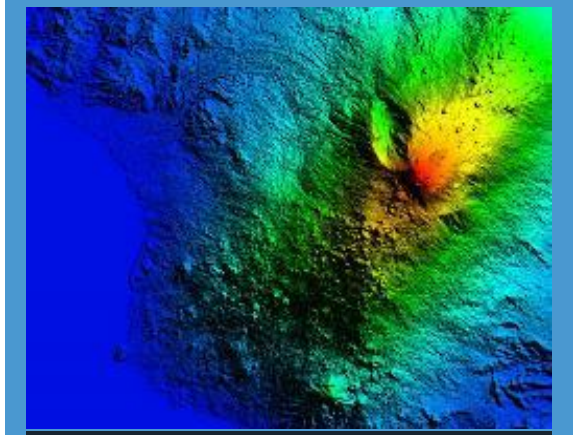
LOCATIONS IN
~30
COUNTRIES

~50K
EMPLOYEES

Geospatial Solutions



Commercial geospatial analytics



Off-the-shelf and custom geospatial products/services

Data and imagery

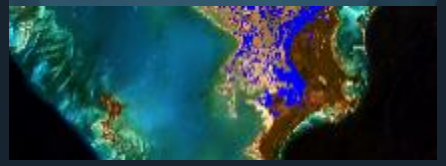
Machine learning technologies

Core offerings

We have more than 30 years of experience developing scientifically proven solutions using cutting-edge technology. Today, organizations across industries use our in-depth knowledge of advanced geospatial analytics, machine learning and remotely sensed data to make better decisions.

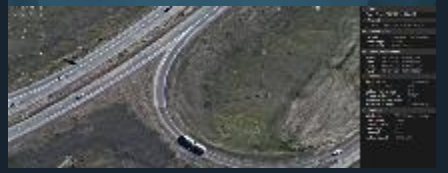
ENVI®

ENVI® SARscape®



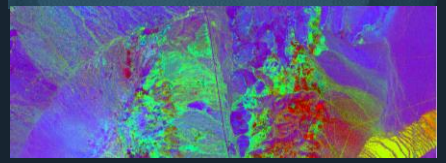
IDL®

Jagwire™



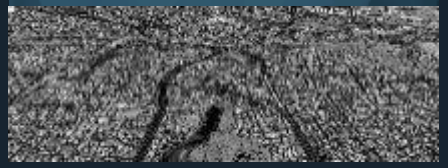
Amplify™

GSF



Helios®

Data & Imagery



MicaSense

Most trusted brand in drone-based, multispectral imaging since 2014

- Engineers, Remote Sensing Scientists, and GIS specialists
- Sensors designed and manufactured in Seattle
- Global presence in over 70 countries through reseller network
- Platform agnostic products
  - Sensors integrate with most drones.
  - Data can be processed in third-party softwares

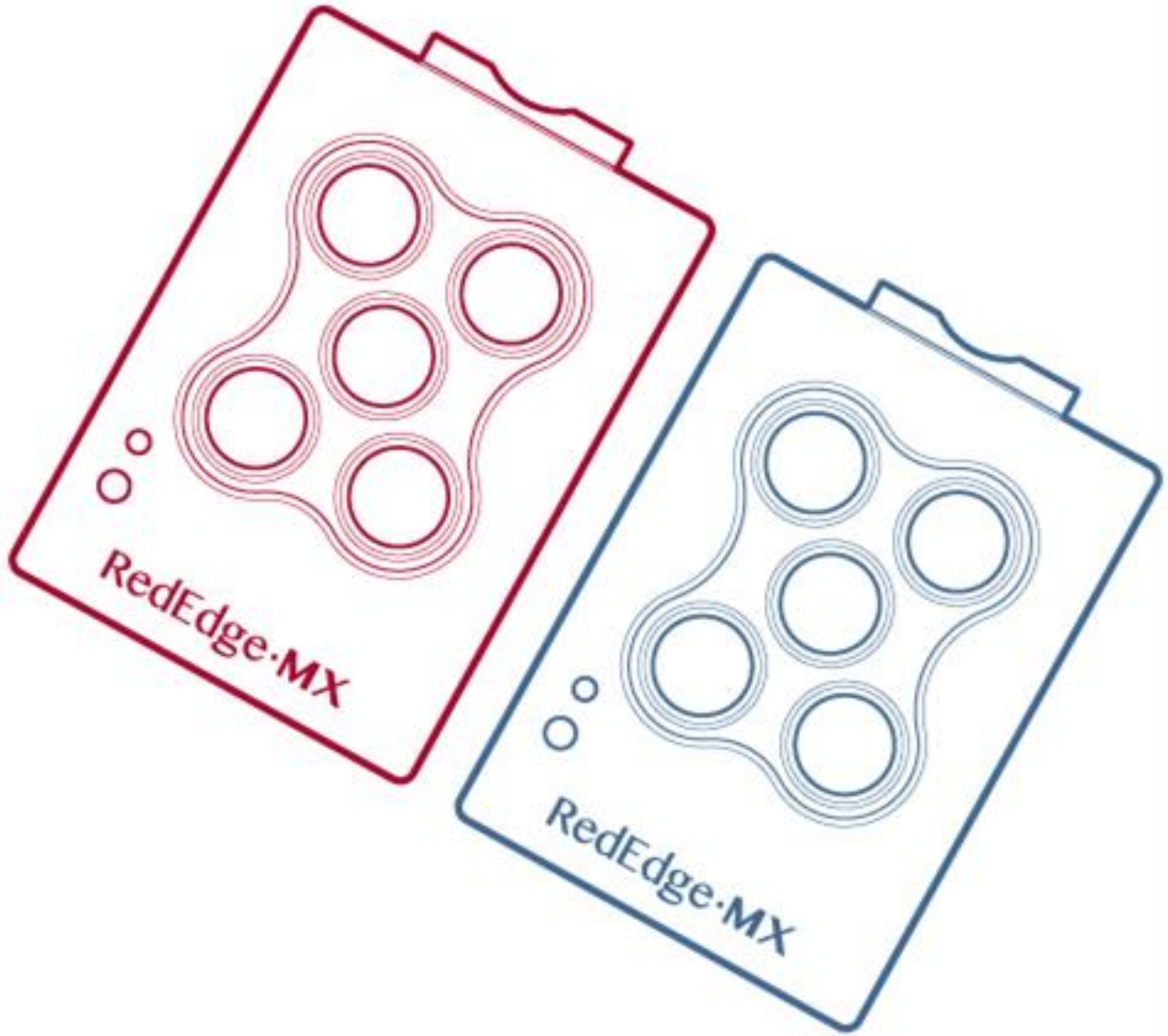
Poll Question

Which remote sensing methods do you utilize?

- ❑ Satellite
- ❑ Manned Aircraft
- ❑ Drones
- ❑ Combined approach

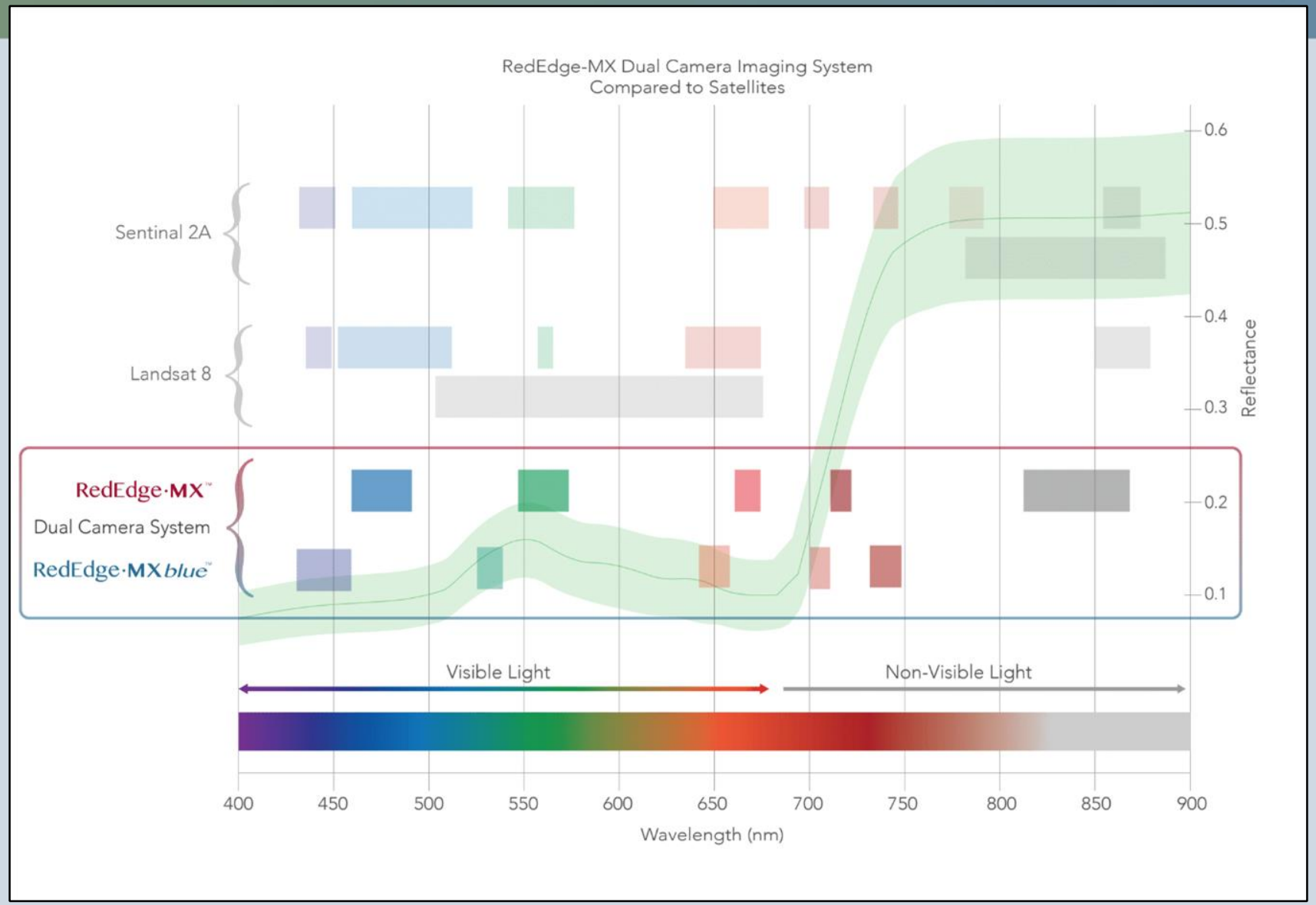
Dual Camera System,

10 multispectral bands



Drone Integrations

Filter Selection



Spectral Quality

- Narrow bandwidths. One filter per sensor.
- Multiple checks for optical quality completed before any camera ships
  - Filter manufacturer ensures wafer is within spec and uniform before dicing desired filter sizes.
  - Once camera is assembled, MicaSense calibrates each unit before shipping. Calibrations cover:
    - Distortion
    - Radiometric correction
    - DLS2 calibration

Comparison with Landsat 8 and Sentinel 2A

	LANDSAT 8	SENTINEL 2A	DUAL CAMERA SYSTEM
COASTAL AEROSOL	443 (16)	442 (20)	444 (28)*
BLUE	482 (60)	490 (66)	475 (32)
GREEN			531 (14)*
	560 (60)	560 (36)	560 (27)
RED	654 (37)		650 (16)*
		664 (30)	668 (14)
REDEDGE		704 (15)	705 (10)*
			717 (12)
		740 (15)	740 (18)*
		782 (20)	
NIR		832 (100)	
	864 (28)	864 (21)	842 (57)

* Denote RedEdge-MX Blue bands

Coastal Blue

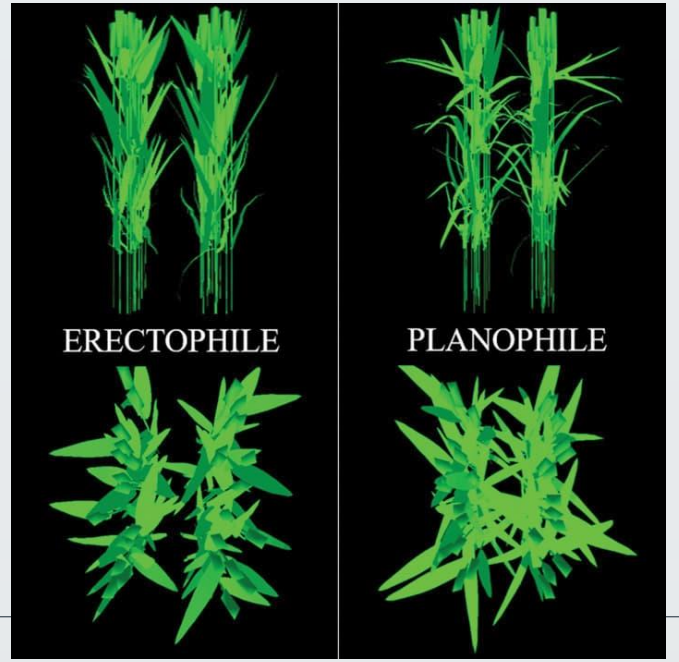
Band 1 : 444-10

- Classifying invasive emergent aquatic reeds.
- Stream depth for monitoring shallow stream channel change
- Reflects blues and violets, displays subtle differences in the color of water; can indicate what is mixed in the water (i.e., suspended sediments)

Red Edge 705

Band 7: 705-10

- Superior to 717 for identifying chlorosis. Great for leaf roll or leaf blotch as well.
- Mentioned in multiple publications as key in identifying micro/macro nutrient deficiency.
- Better for planophile canopies (i.e., soybeans, potatoes).



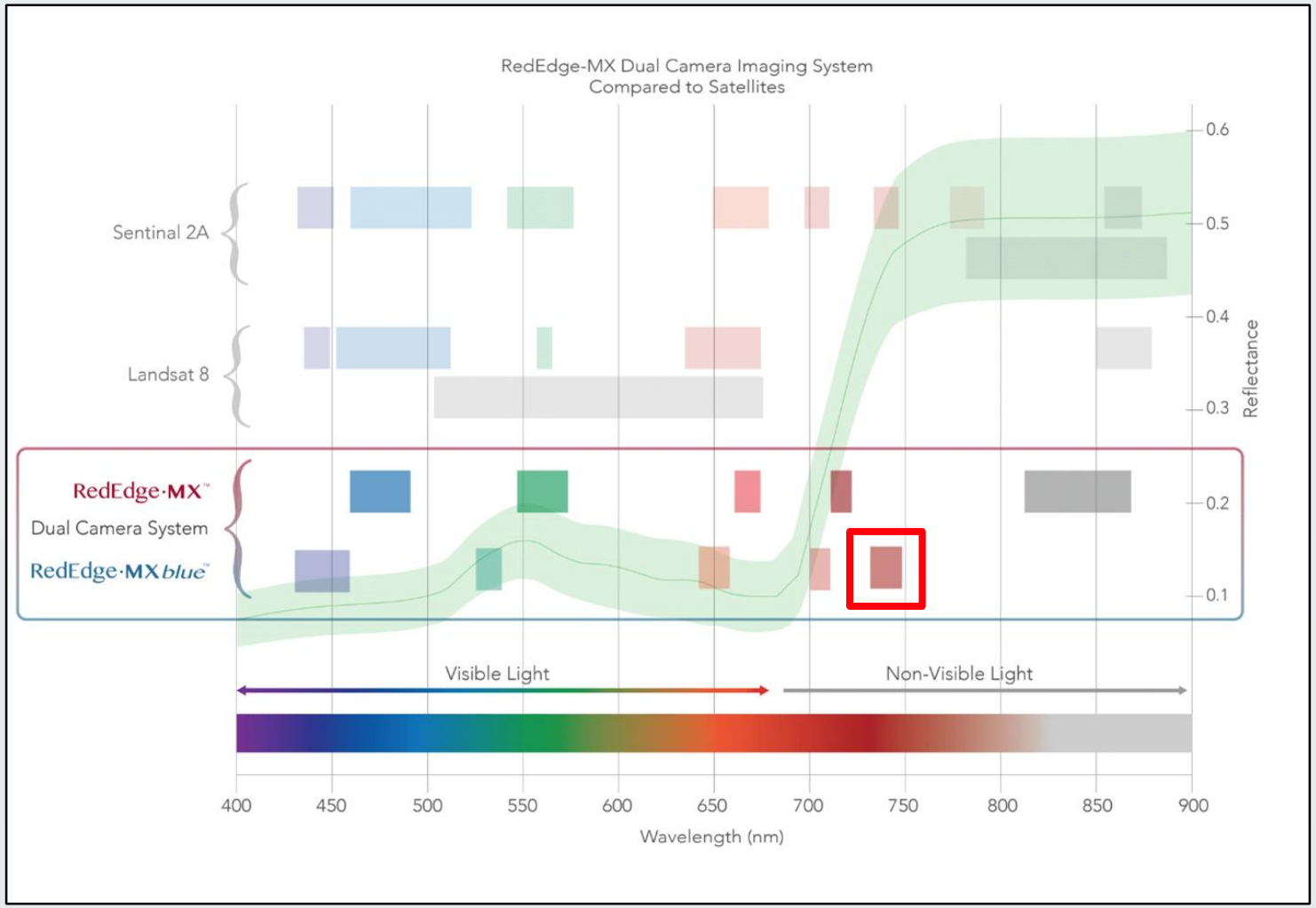
Red Edge 740

Band 9: 740-18

- Matches Sentinel-2A red edge band
- Capability to develop the red edge position index (REP) simply by the ratio 740/705
- Three different options for NDRE:
  - (840 - 705)/(840 + 705)

    or
  - (840 - 717)/(840 + 717)

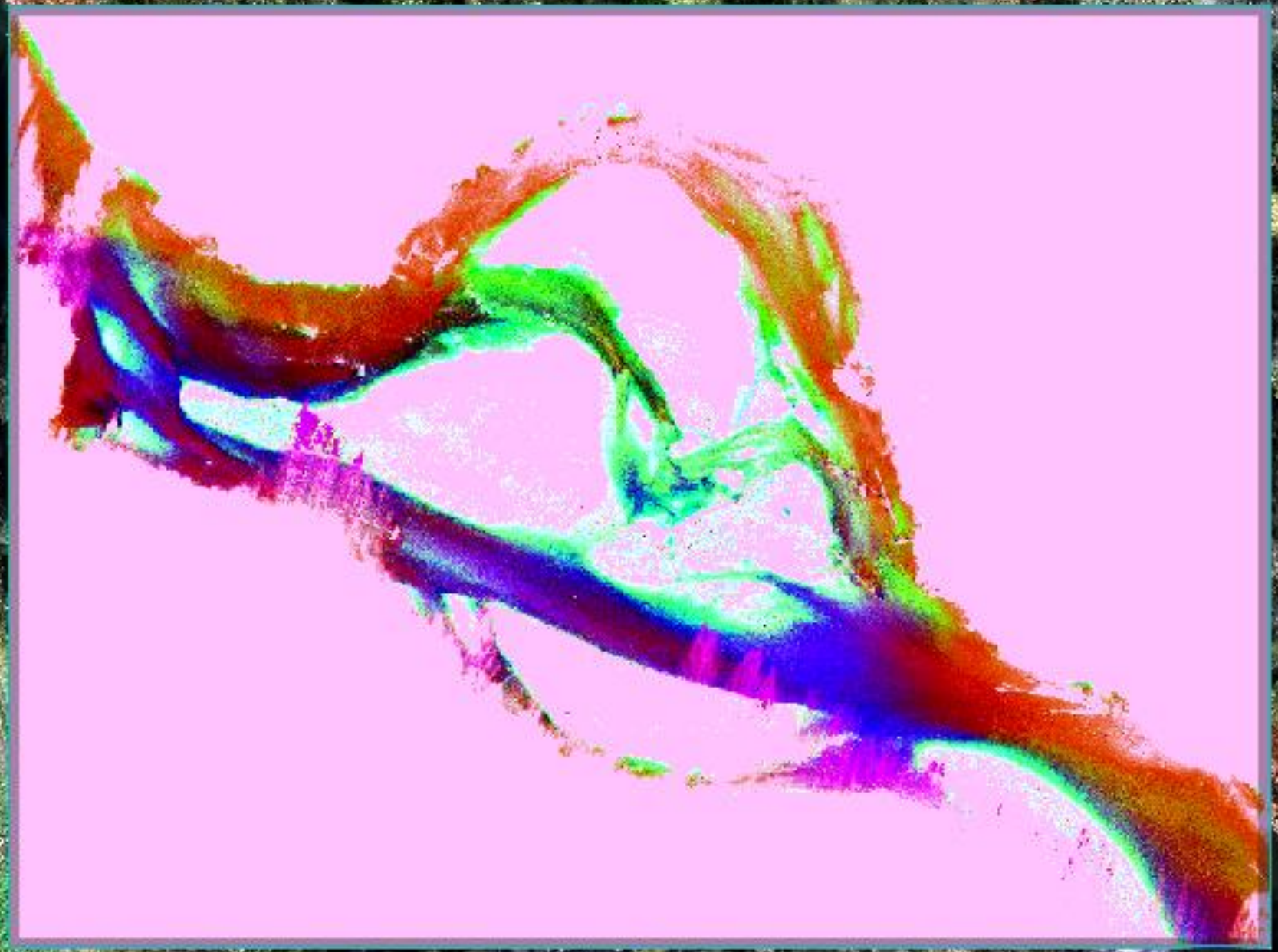
    or
  - (840 - 740)/(840 + 740)



Processing 10-band data

https://github.com/micasense/imageprocessing

Pulling Out Information with ENVI



Bands and Spectral Indices

- Spectral indices are mathematical formula that use two or move spectral wavelengths to highlight specific features including vegetation, mineralogy, and burn area.
- ENVI comes with over 65 pre packaged spectral indices, covering a wide range of physical and chemical characteristics

$$NBRT = \frac{(NIR - SWIR\left(\frac{Thermal}{1000}\right))}{(NIR + SWIR\left(\frac{Thermal}{1000}\right))}$$

Spectral Indices included in ENVI

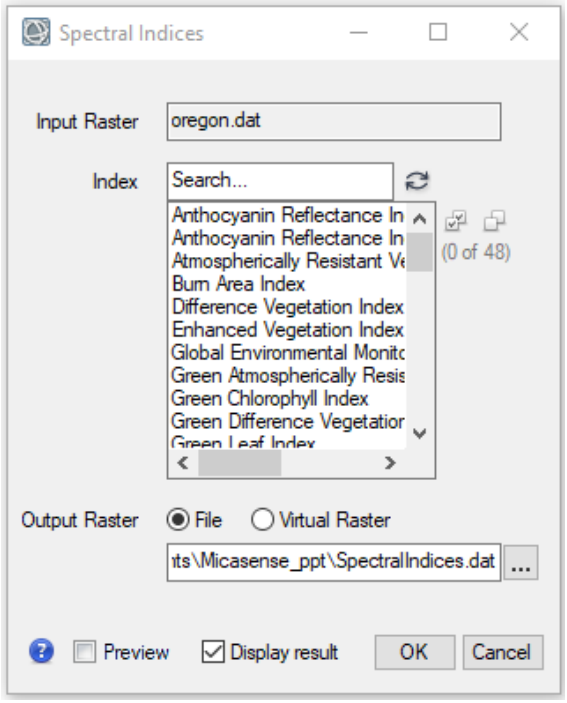
- Vegetation
  - Broadband Greenness
  - Narrowband Greenness
  - Canopy Nitrogen
  - Canopy Water Content
  - Dry or Senescent Carbon
  - Leaf Pigment
  - Light Use Efficiency
- Geology
  - Clay Ratio
  - Ferrous Minerals
  - Iron
  - Soil Indices
- Miscellaneous
  - Burn Indices
  - Water Indices
  - Urban Area Indices
  - Snow Indices
  - Mud Indices
  - Non-homogenous Features (pavement, roofs)
- You can also create your own spectral indices in ENVI itself.

Poll Question

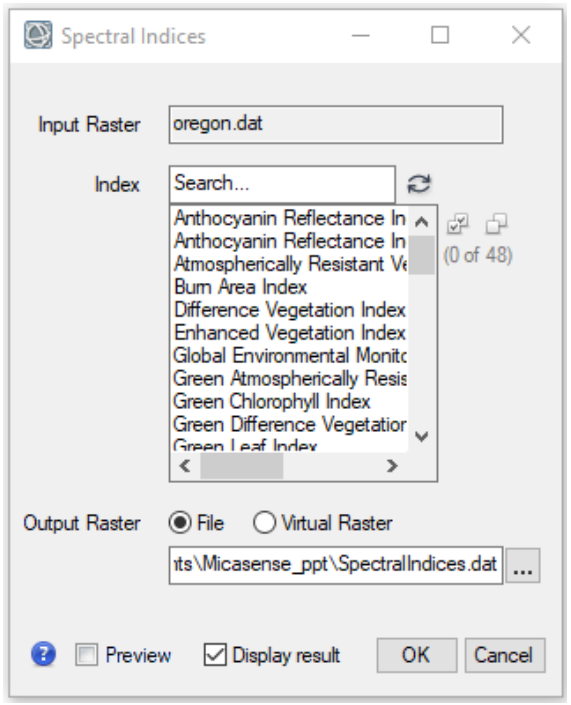
Which category best describes your main application for vegetation mapping?

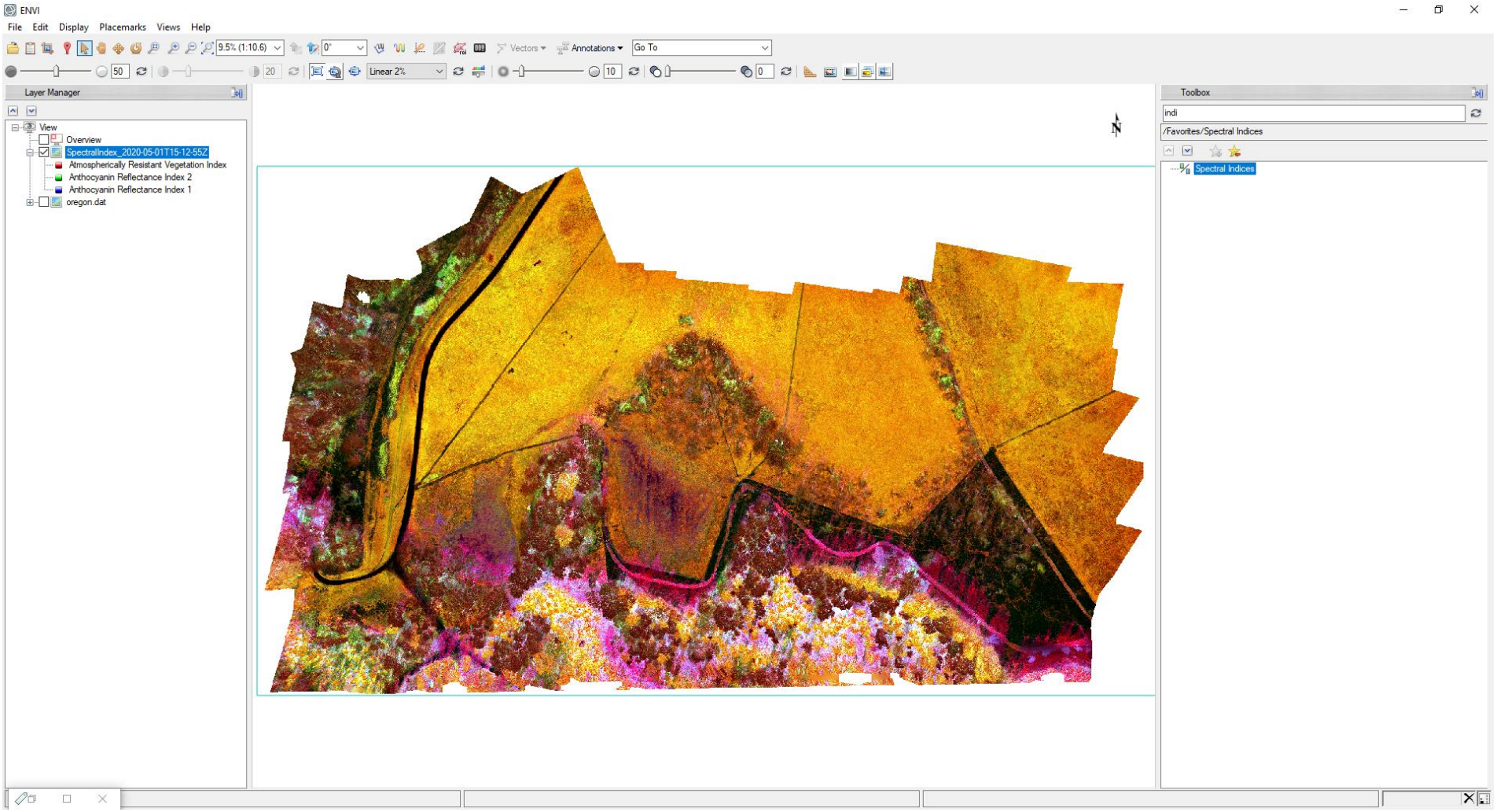
- ❑ Land management
- ❑ Aquatic / coastal environment conservation
- ❑ Forestry
- ❑ Phenotyping / Agricultural research
- ❑ Other

Spectral Indices Cont.

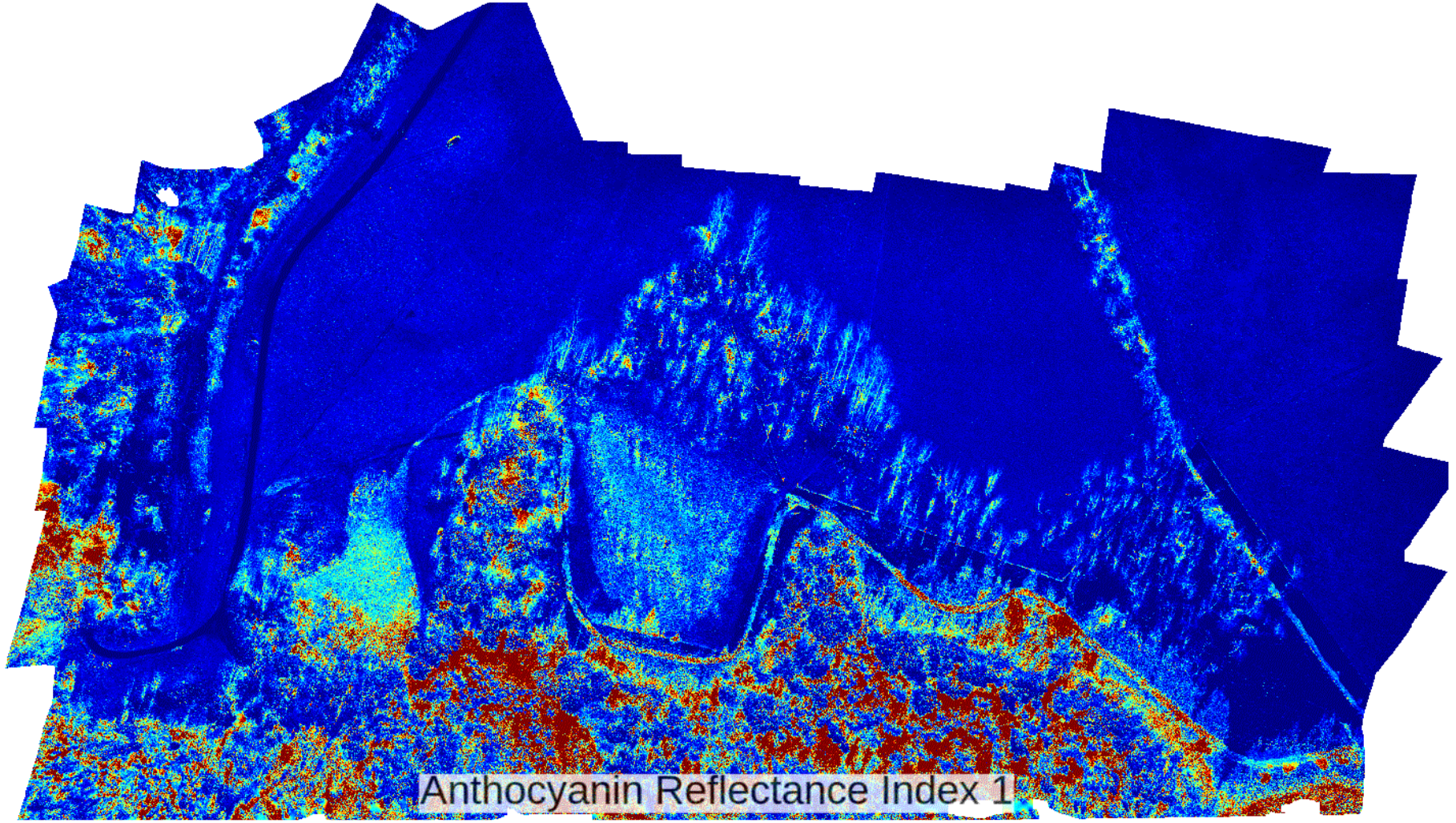


Indices with the MicaSense Dual Camera System

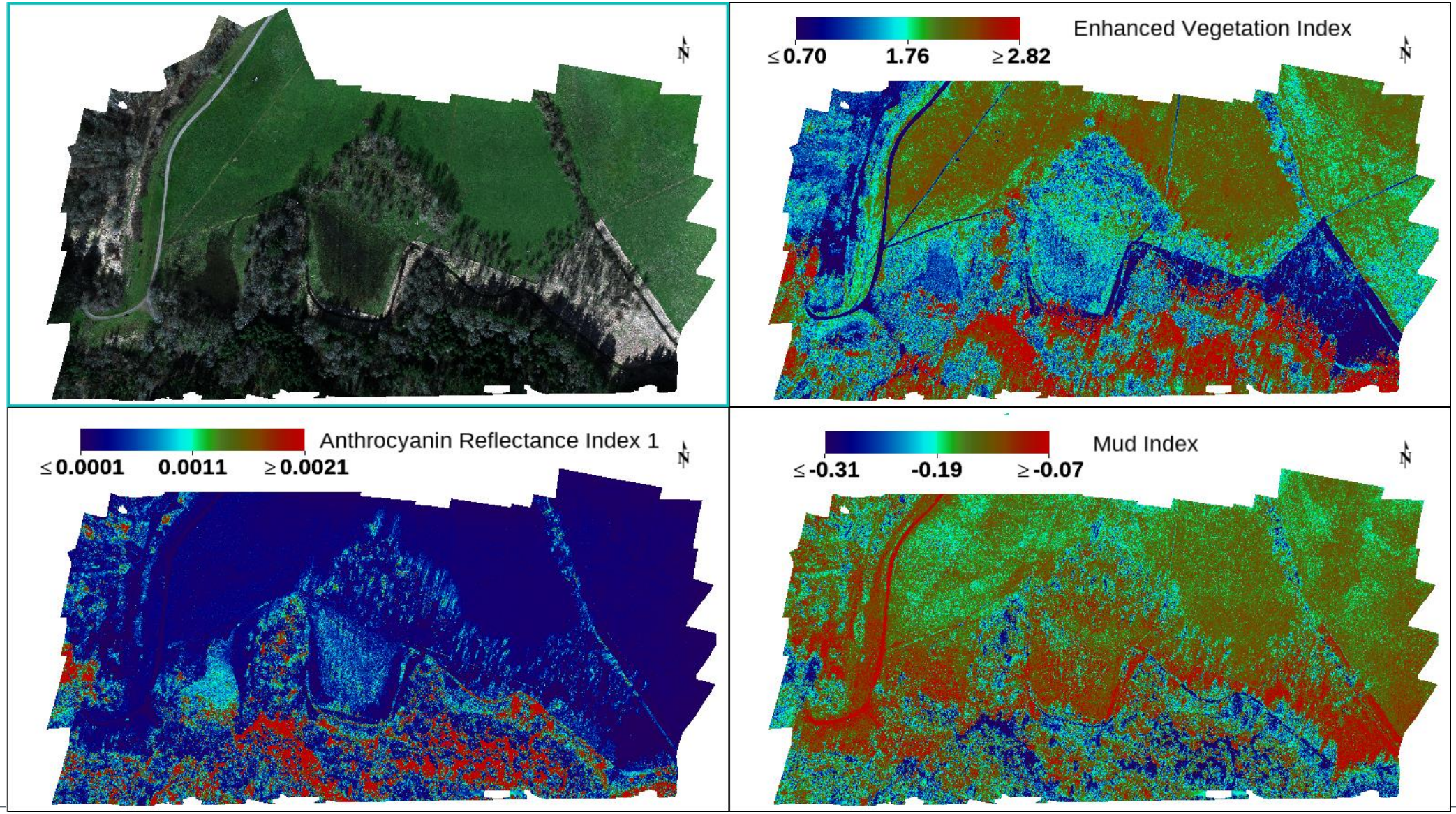




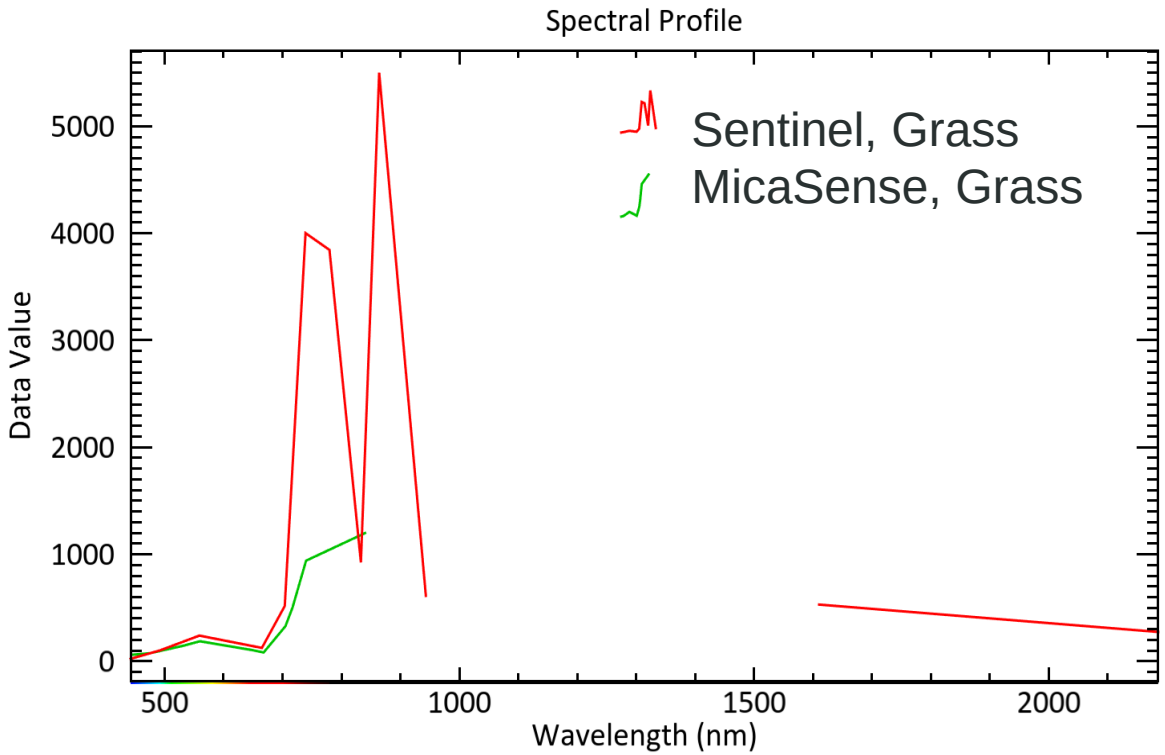
Easy to View

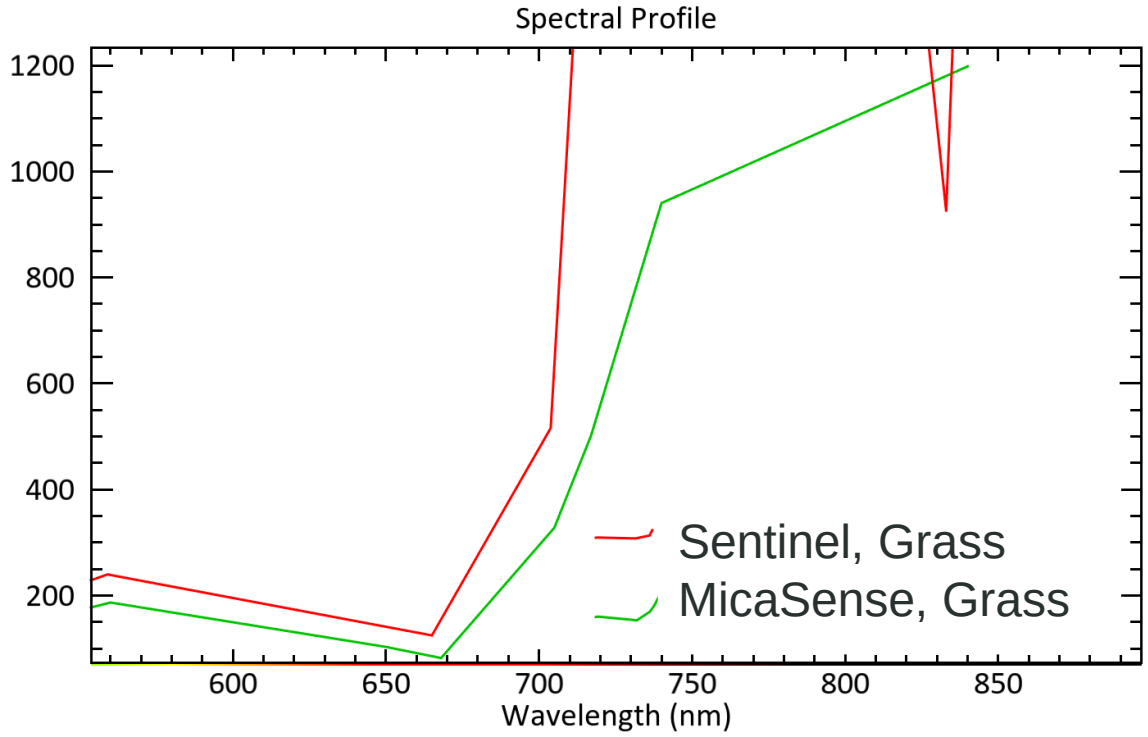


Spectral Index Comparison

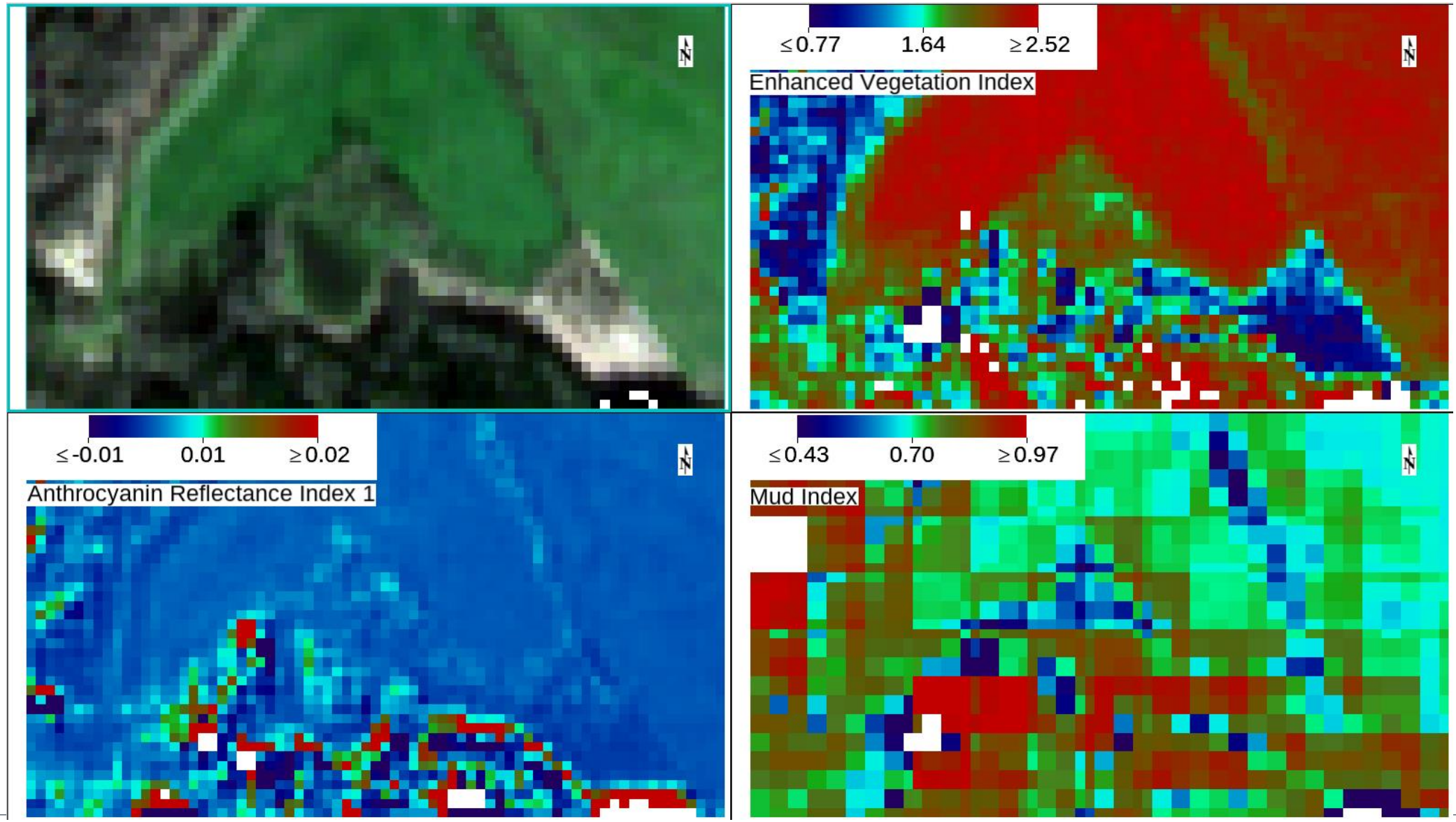


Spectral Comparison

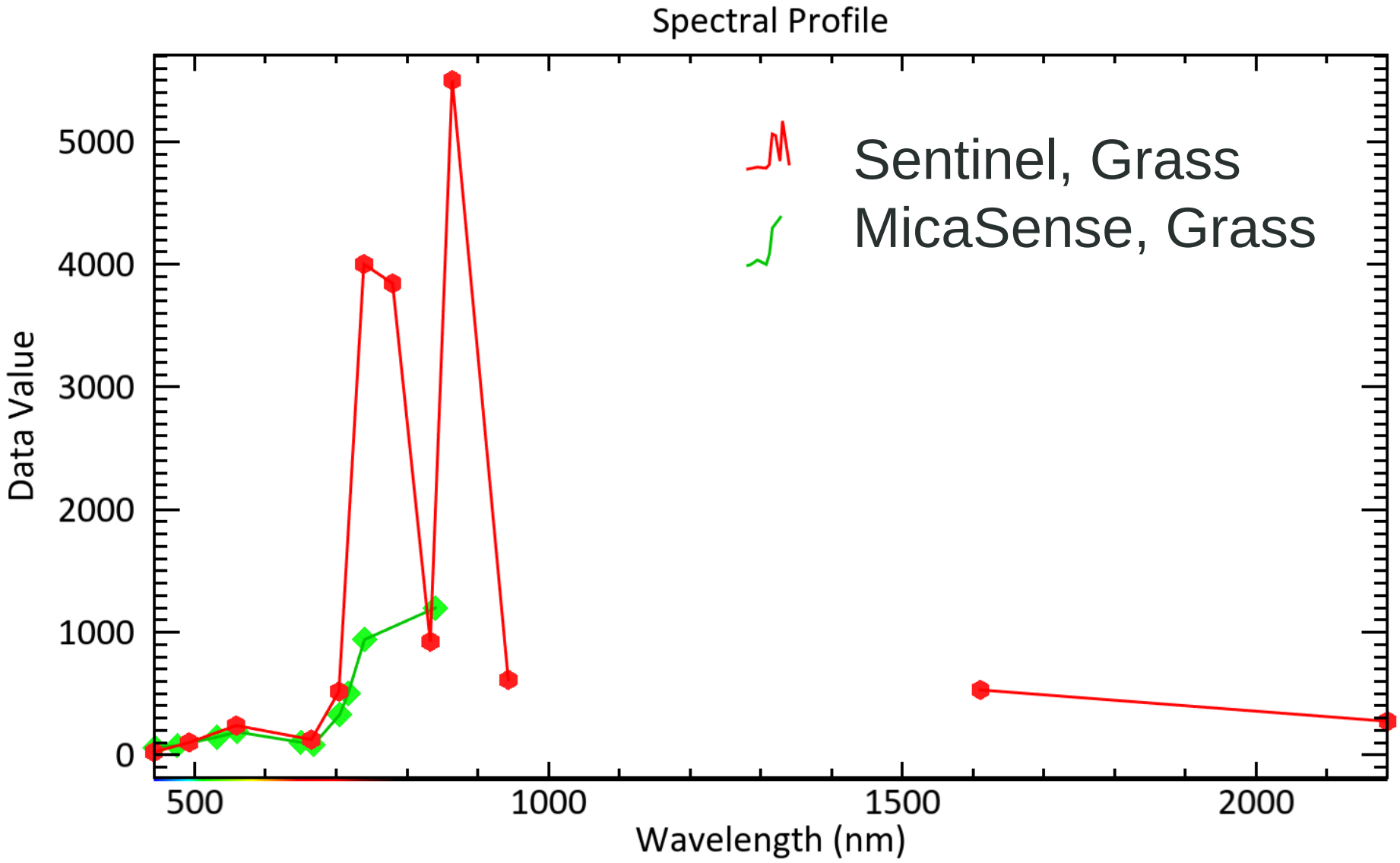




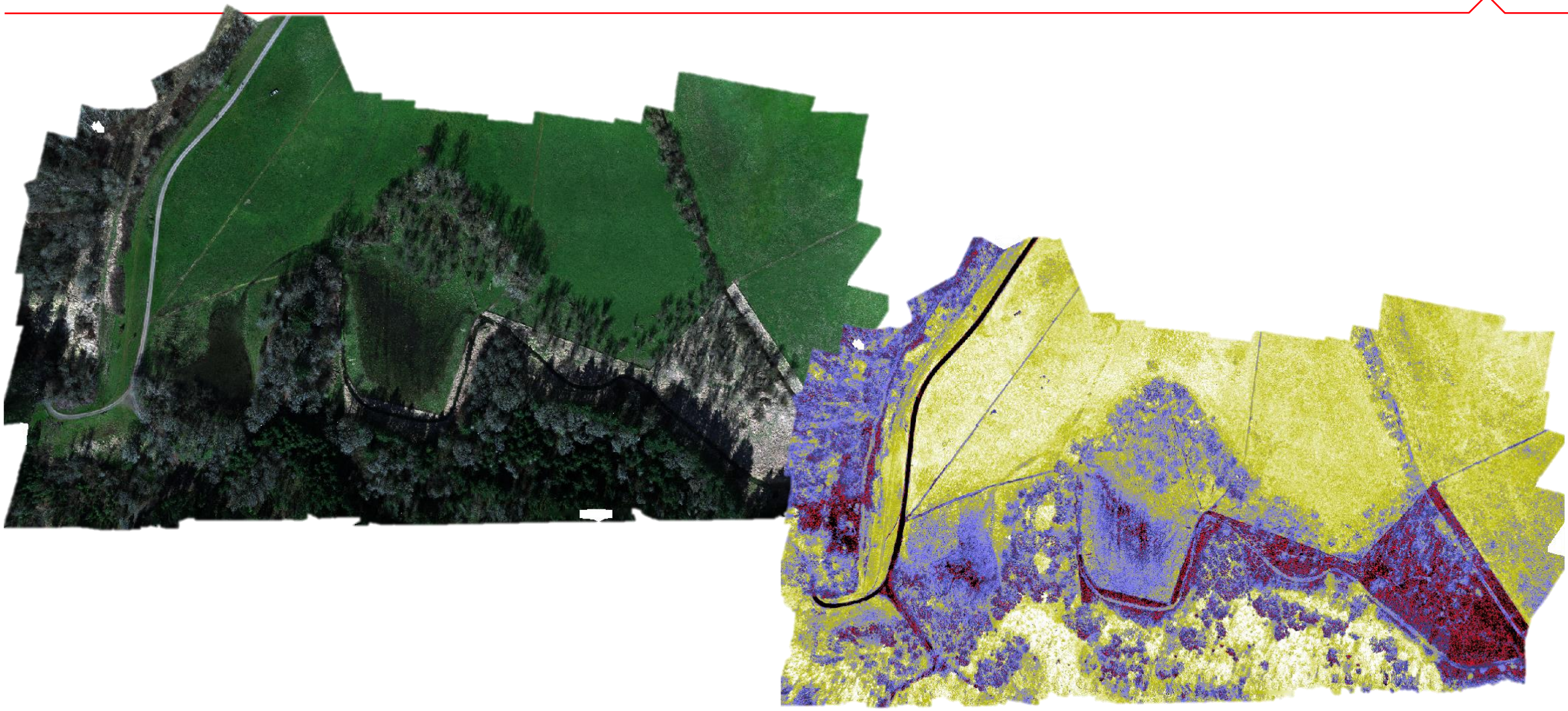
Sentinel-2 Spectral Indices



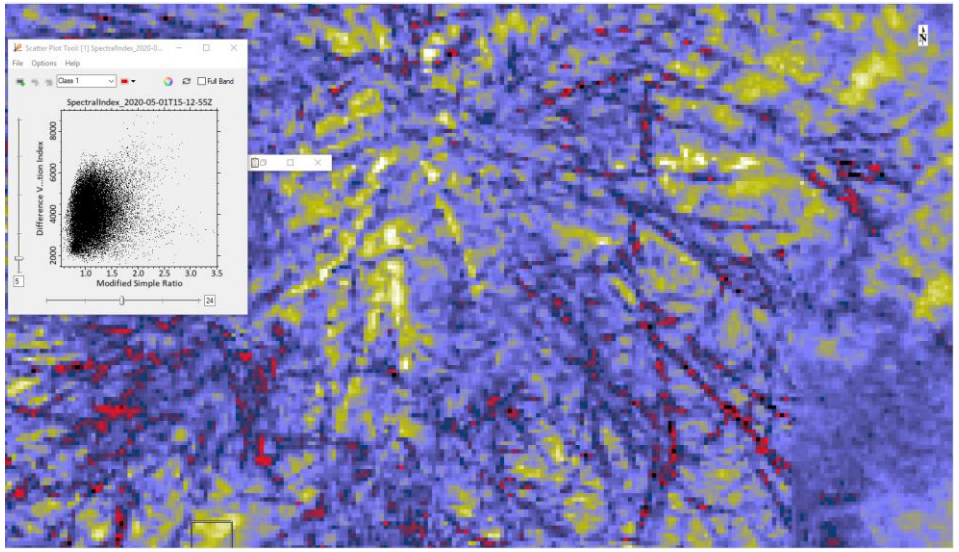
Spectral Comparison

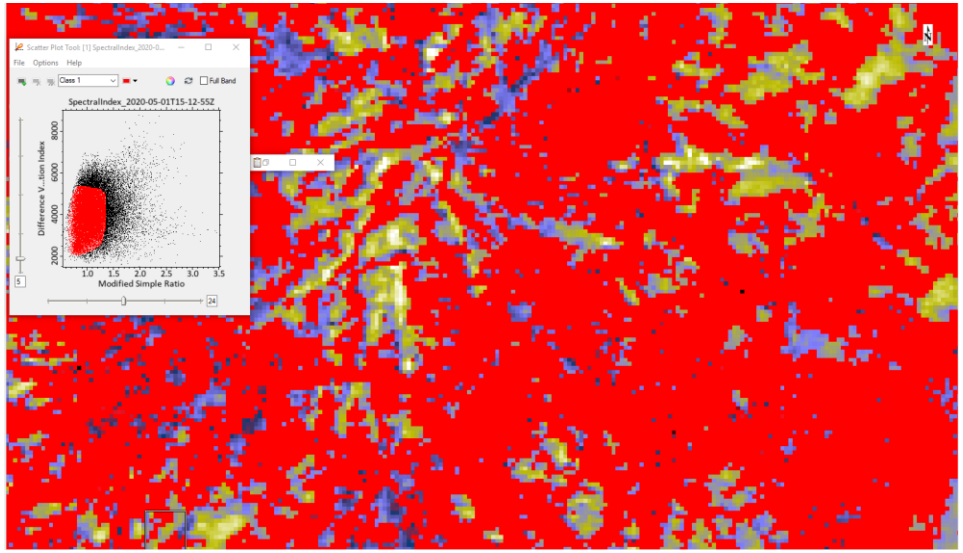


Pulling out Features with Spectral Indices



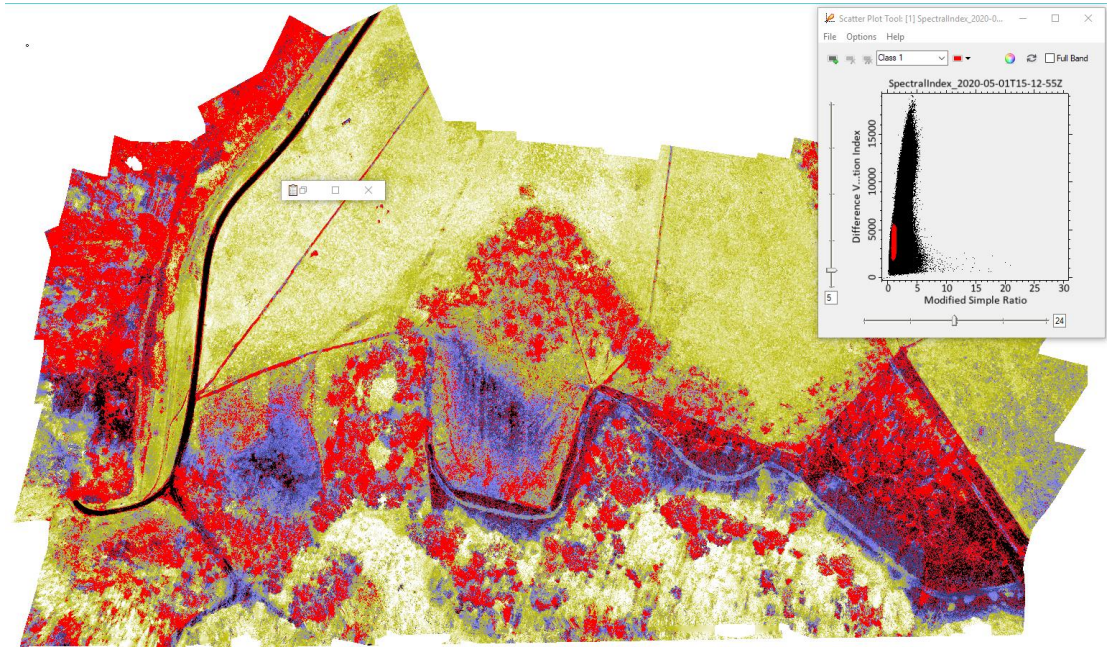
Scatter Plot Tool

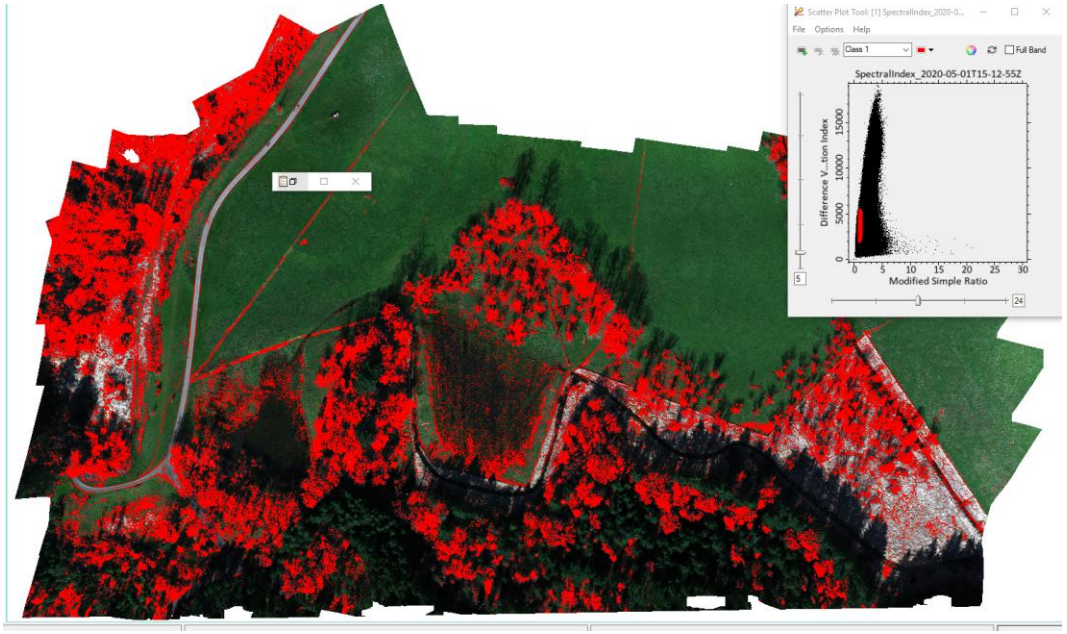




- The Scatter Plot tool can be used to classify features easily in an image.
- Zoom in on the feature and the scatterplot tools screen will fill with what pixels relate to what you see on the screen.
- Highlight those features in the scatterplot, and zoom out!

Classification with Scatter Plot Tool



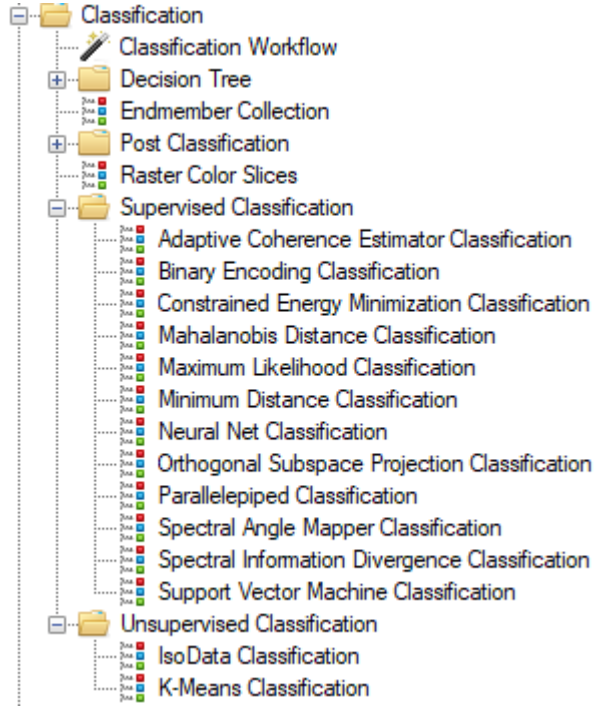


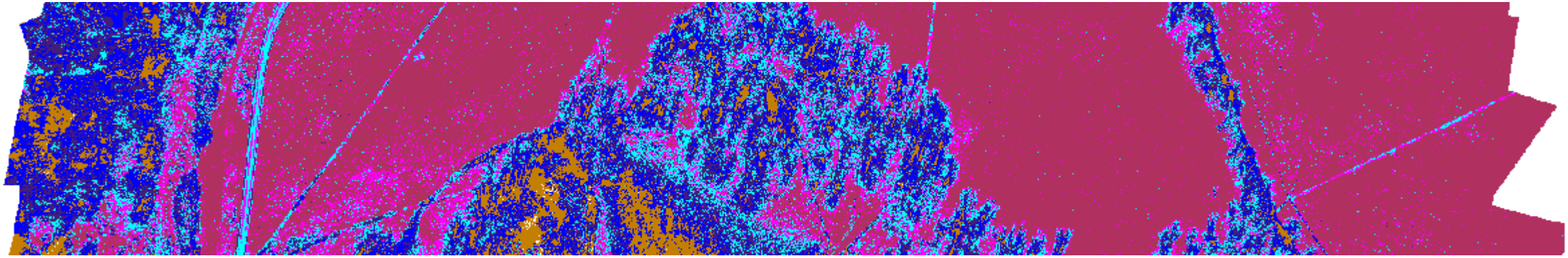
- You can now see where the area we highlighted is compared to the entire scene
- Everything in red is classified as the area of interest, which we can see on the right.
- These AOI can be used for further classification, and to create shapefiles

Classification

- There are many different classification techniques available!
- Unsupervised Classifications: Do not use an user input, will classify based off of grouping pixel statistics together. This is a good technique to use to get to know your imagery, or separate unique features.
- Supervised Classification: Needs user input, either regions of interest, or spectral information, which will be used to find similar pixels and to set bounds as what counts as one class or another.

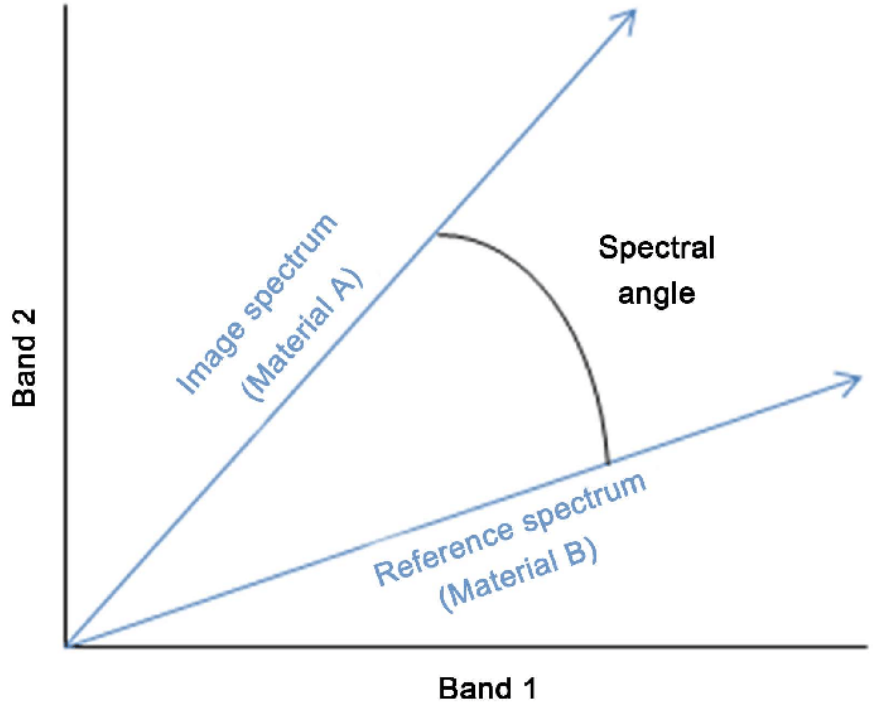
- ENVI also comes with many classification clean up tools such as smoothing, sieving, and clumping.



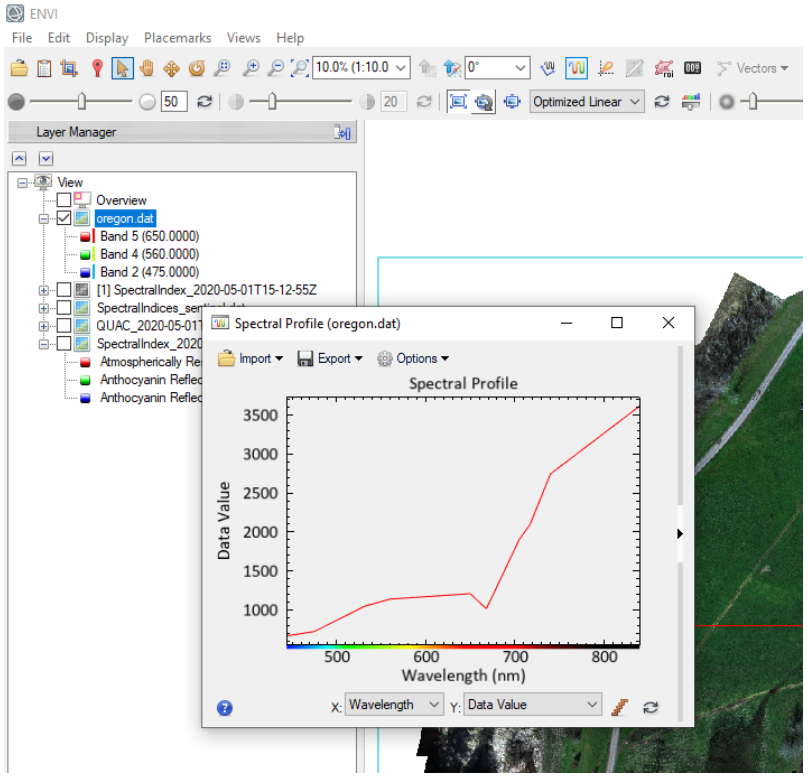


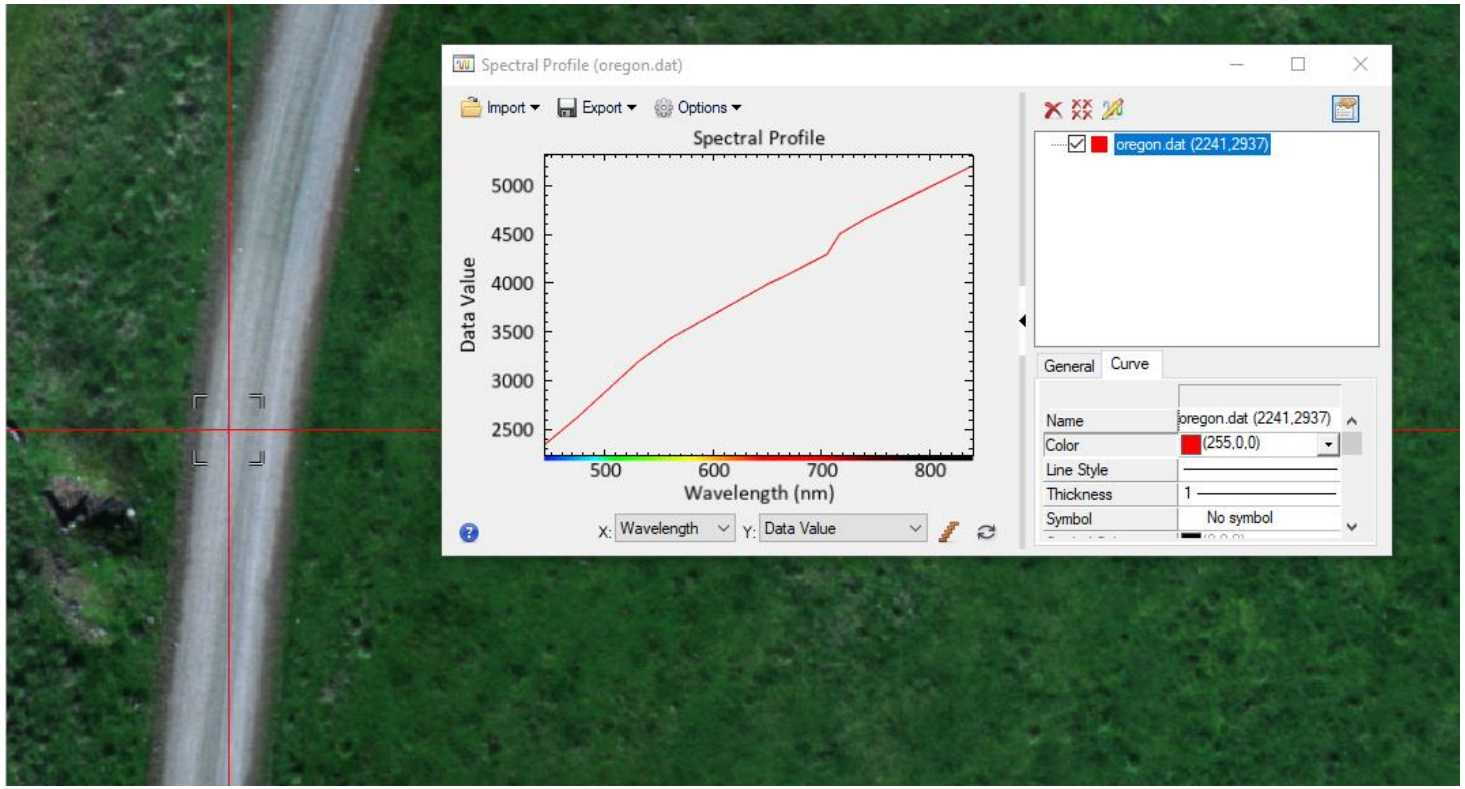
Classifications with Spectral Information

- Spectral Angle Mapper (SAM) will be used for the next few slides
- This technique works well with multispectral and hyperspectral data sets, and will use the unique spectral information to pull out unique features.
- SAM checks the similarity between an input spectrum, and the pixels spectra, and creates an n-dimensional angle between them. It checks this angle similarity between every band portion, and if it is close enough, it is classified as that type of feature.
- Smaller angles mean that the features are more similar.



Picking Spectra



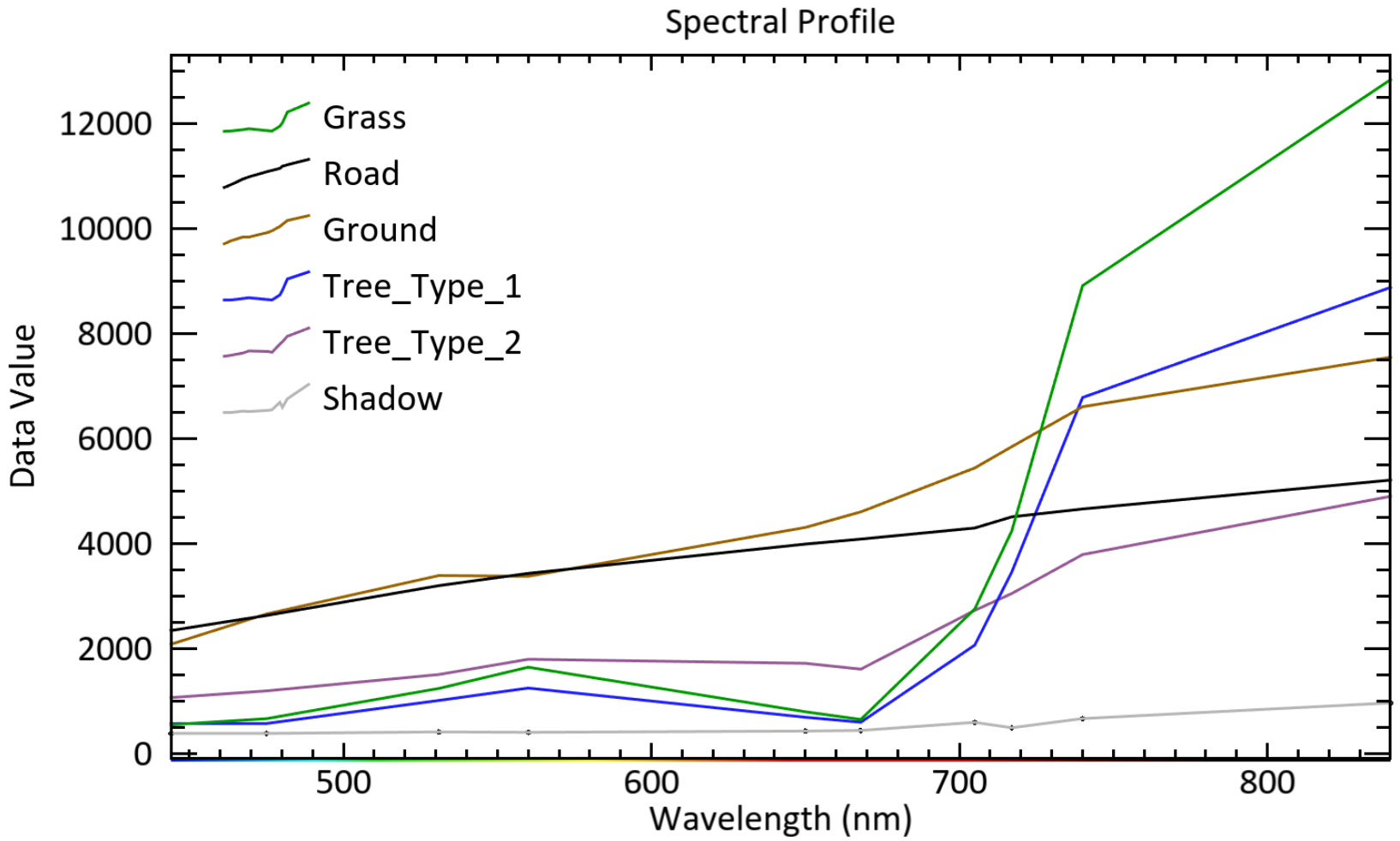


We are going to pick specific points to use as our spectra, which can be done with the Spectral Profile tool.

Clicking on the pixel of interest will pull up its spectral profile in the imagery, and by Shift+Clicking more profiles can be added for different pixels.

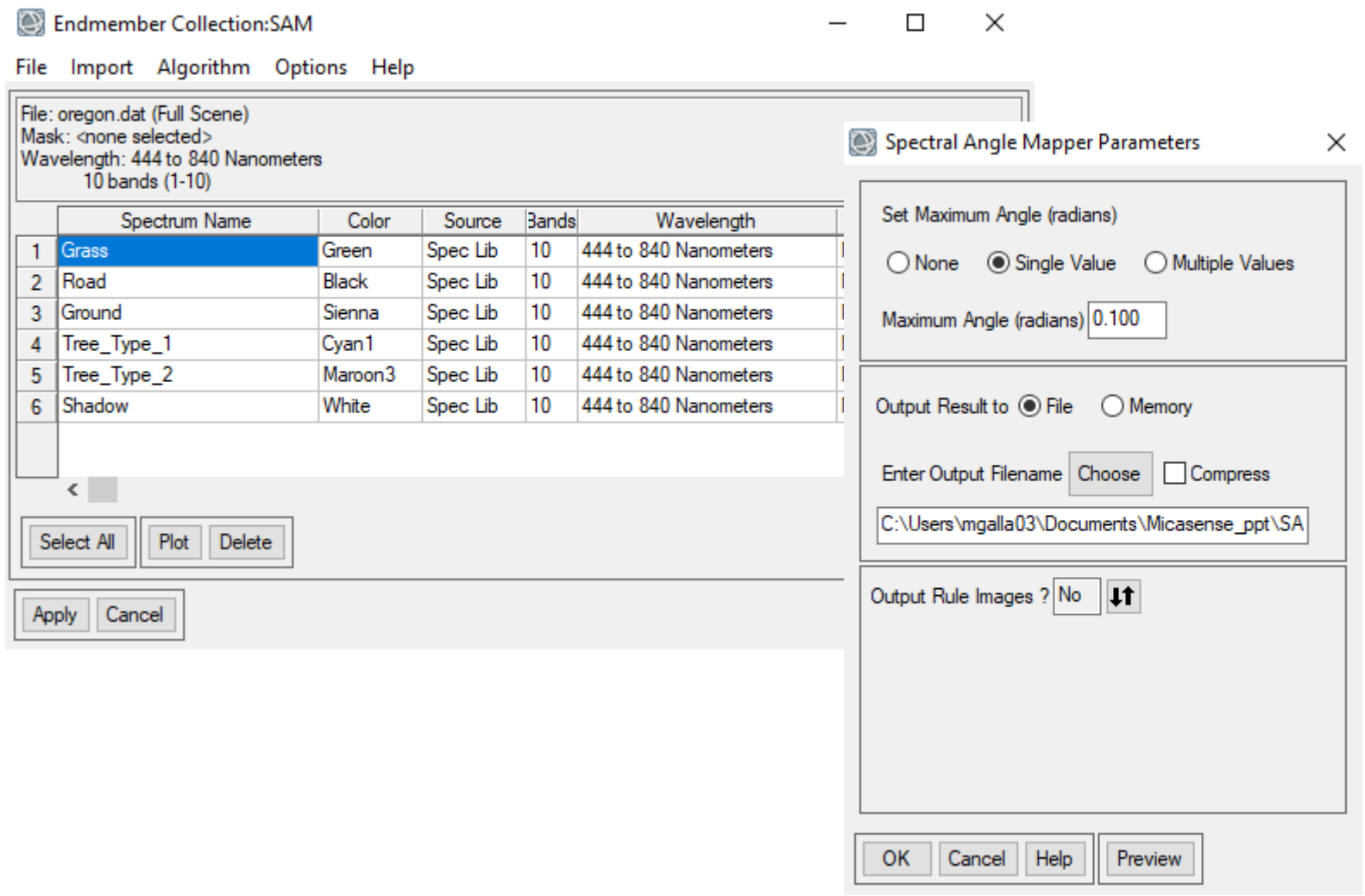
Spectrum of Interest

- For this example, 6 different spectra are chosen.
- Shadow is included as a catch all for darker areas.
- There are similarities between Grass and Tree Type 1, as well as Ground and Road, though the inclusion of further wavelengths does help separate those out.

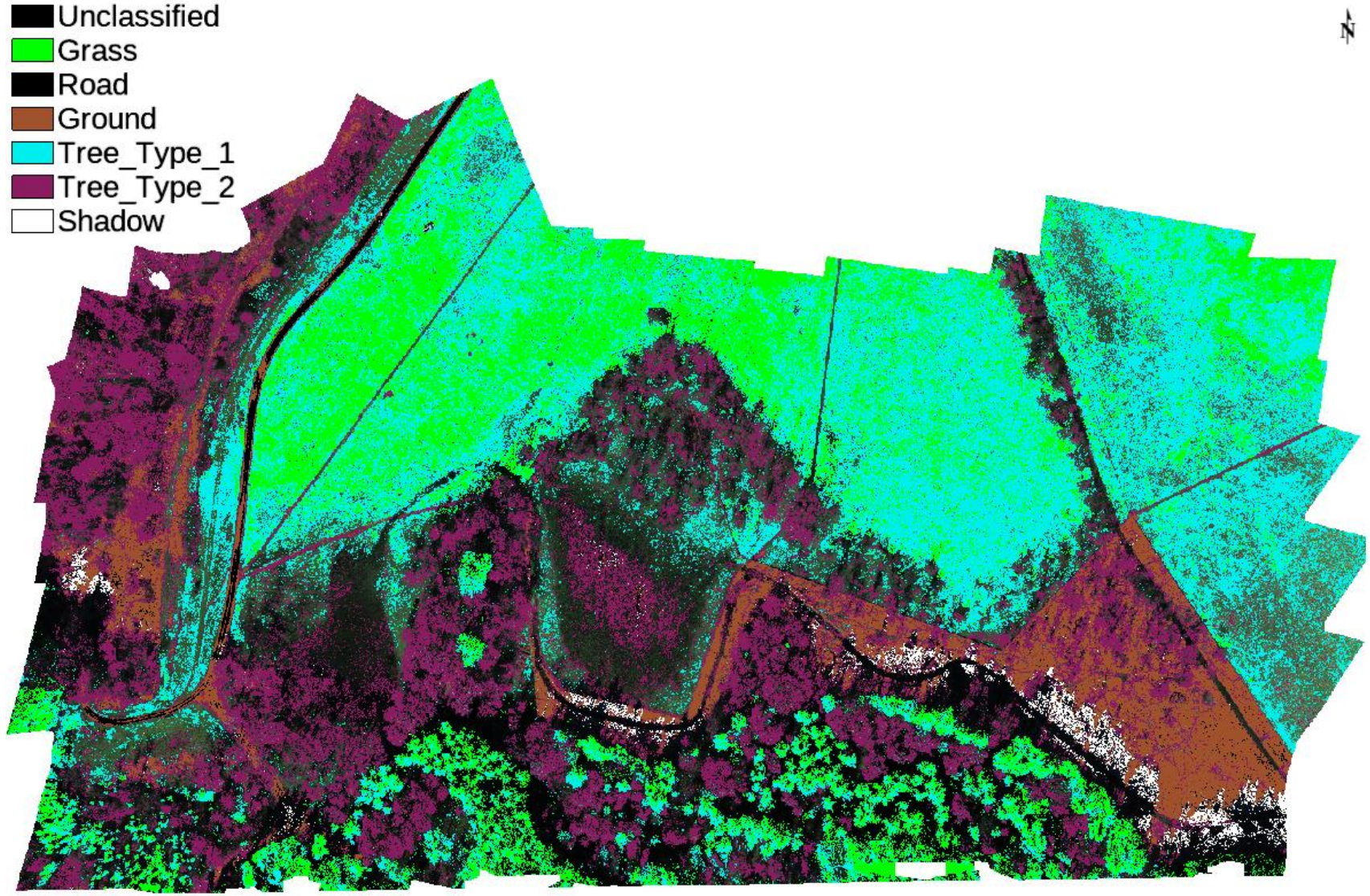


SAM Workflow

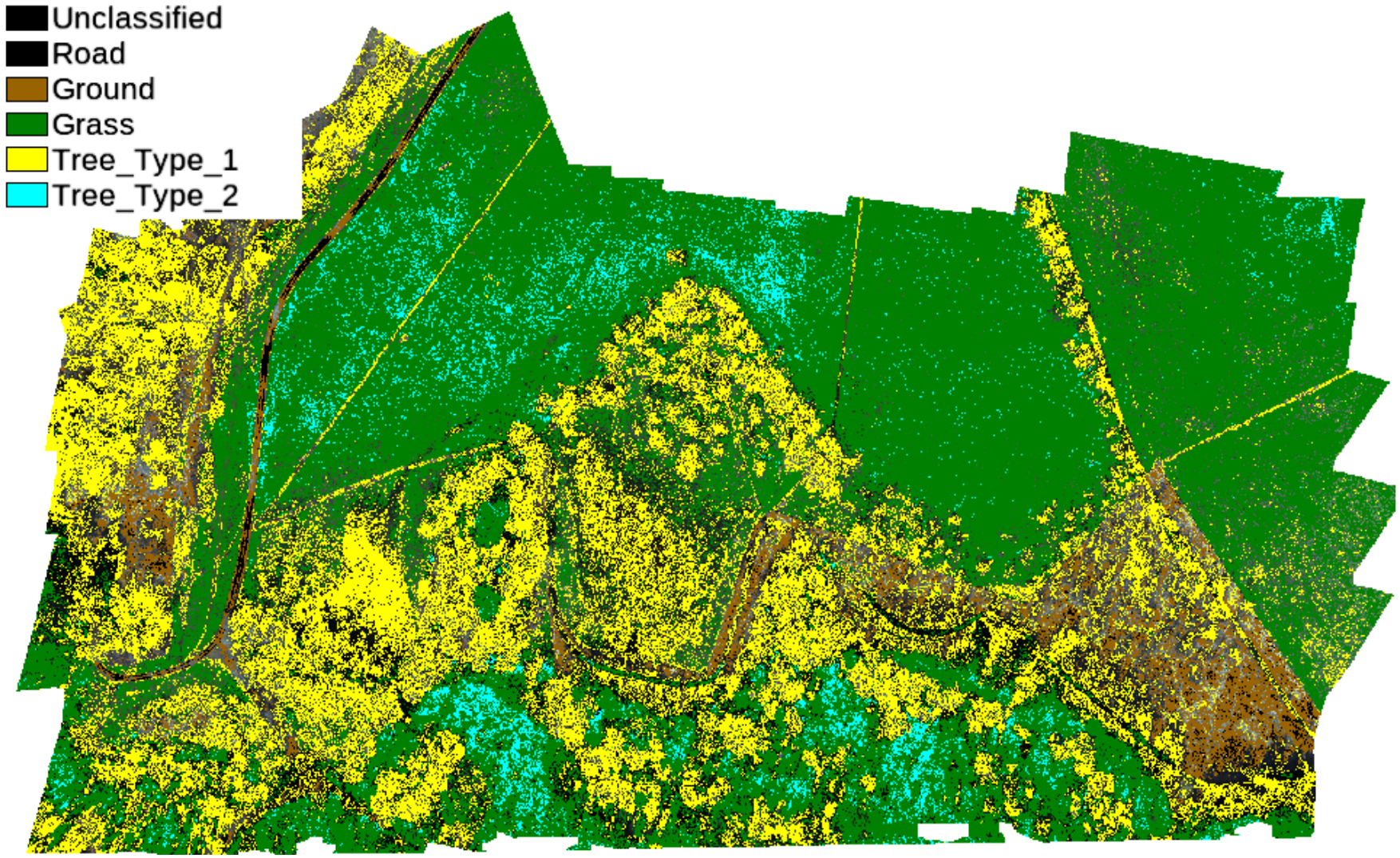
- These spectra can be made into a spectral library, and imported into the SAM workflow.
- The maximum angle that is allowed for classification is 0.1 for all features.
- This can be changed if you want specific features to have a higher or lower chance of being classified.



True Color Image Classification

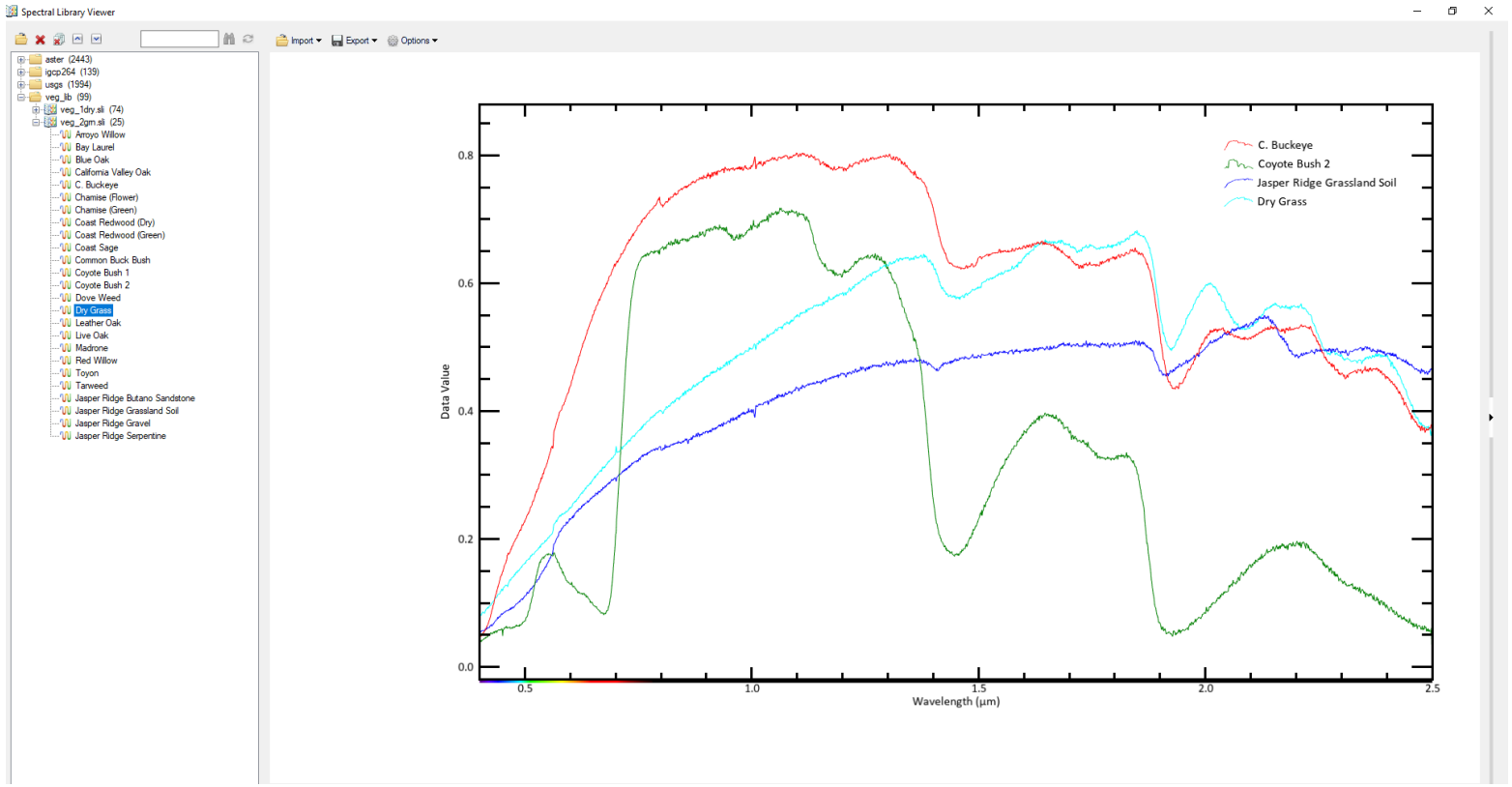


Spectral Profile Classification



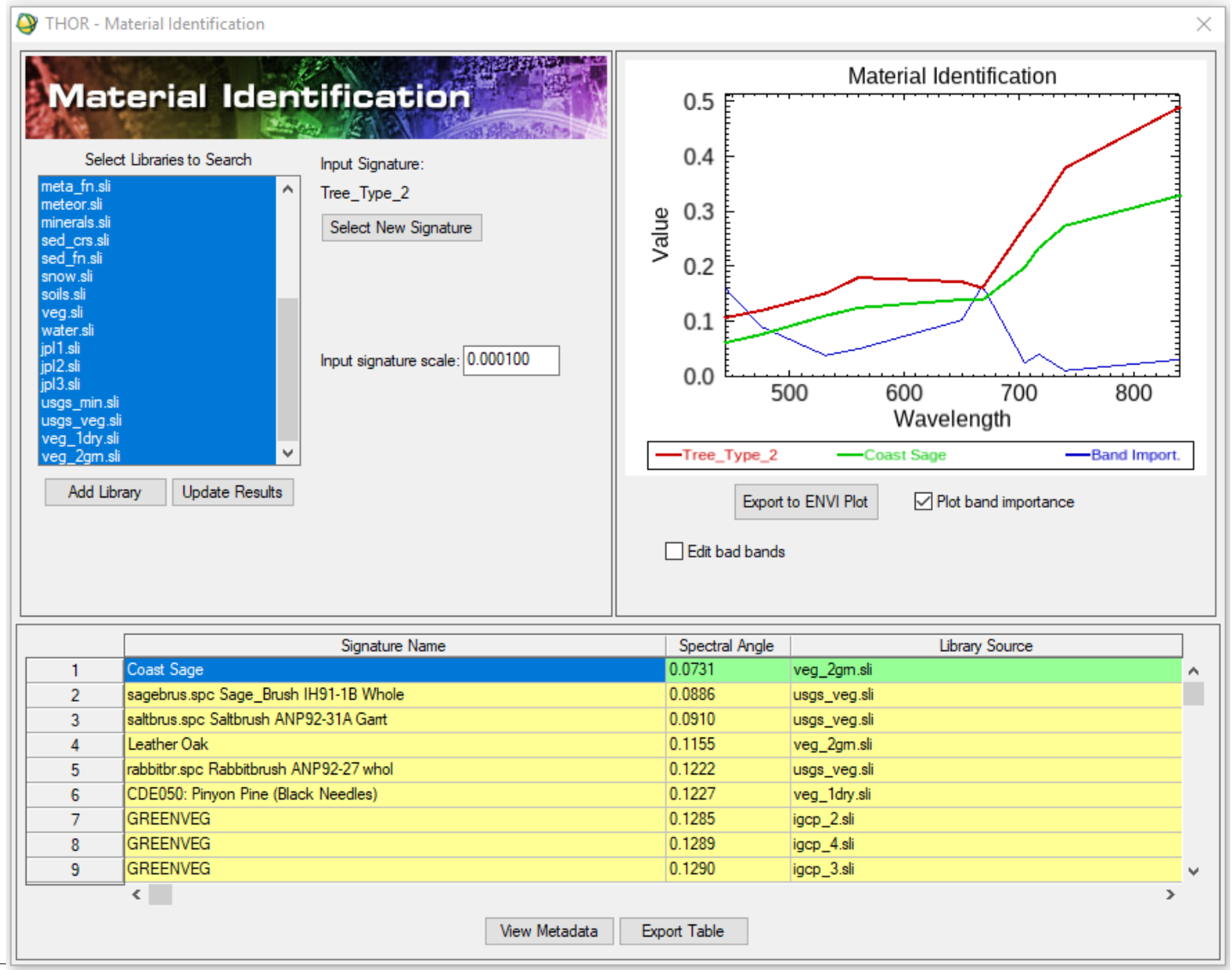
Spectral Libraries

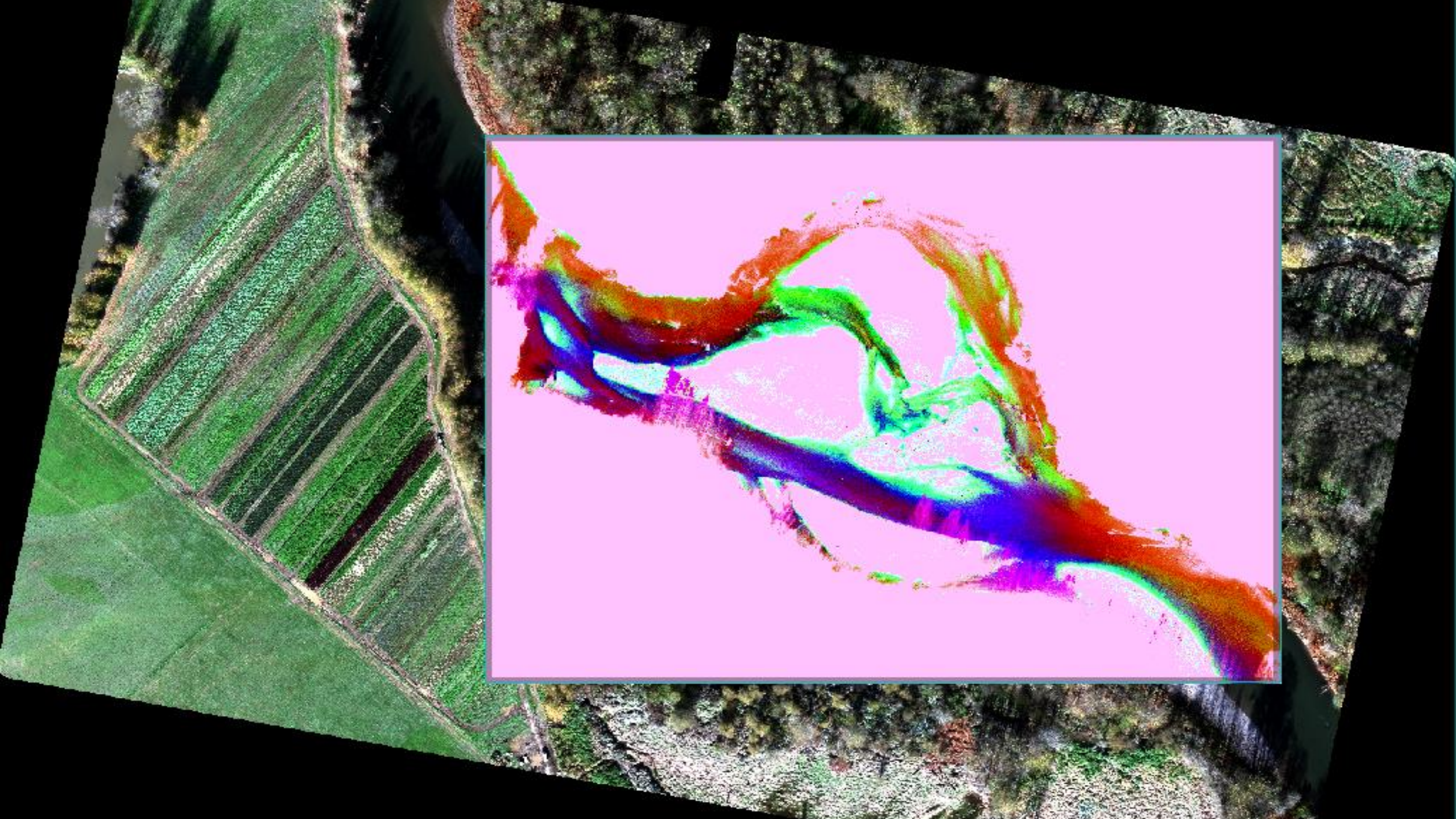
- ENVI comes with multiple spectral libraries available!
- These hold spectrum information about different kinds of vegetation, minerals, and man made features.
- These are usually collected in labs, or with hyperspectral cameras, and so have high spectral resolution.
- You can create your own spectral libraries, or apply any of these to your data for classification.



Material Identification

- One way to use the spectral libraries is for Material Identification.
- By choosing a spectra, you can load it in and easily compare it to every known spectra in ENVI.
- The smaller the spectral angle, the more similar the items are.
- This example shows that Tree_Type_2 is most similar to Coastal Sage, with other kinds of sage brush closely following behind.





Questions?

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Email: Megan.Gallagher@L3Harris.com