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LAB 11 ASSIGNMENT

CE 593 ADVANCED REMOTE SENSING

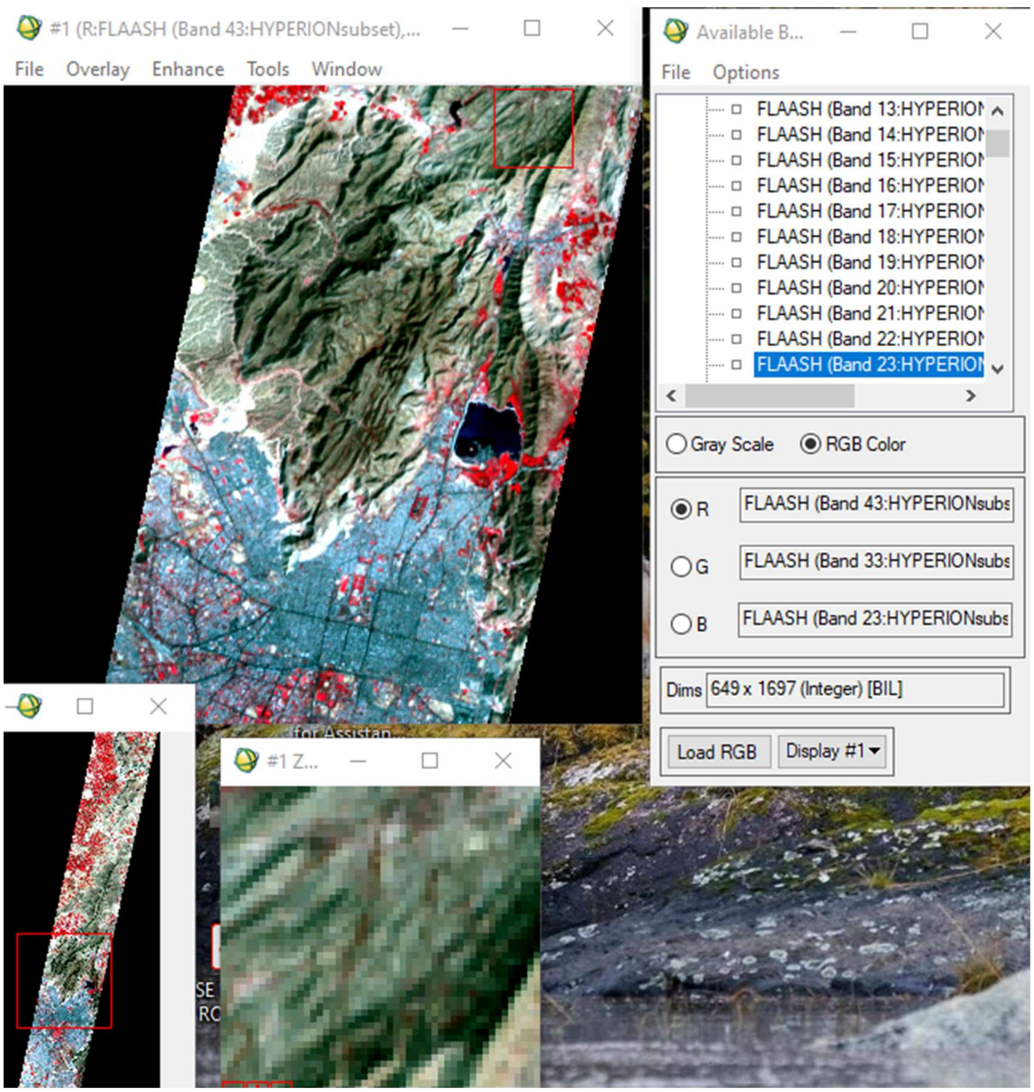
Spectral Hourglass for Hyperspectral Data Analysis

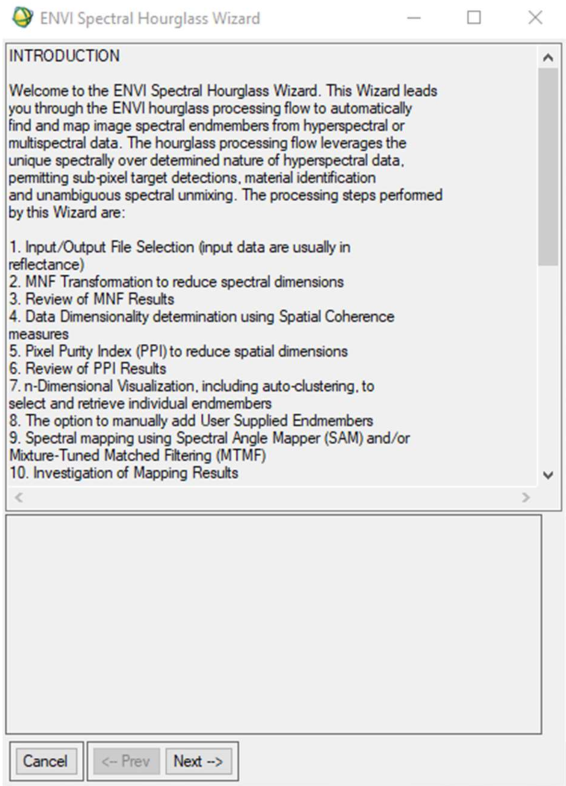
The hourglass processing flow analyzes hyperspectral data to find spectrally pure pixels (endmembers) and map their locations.

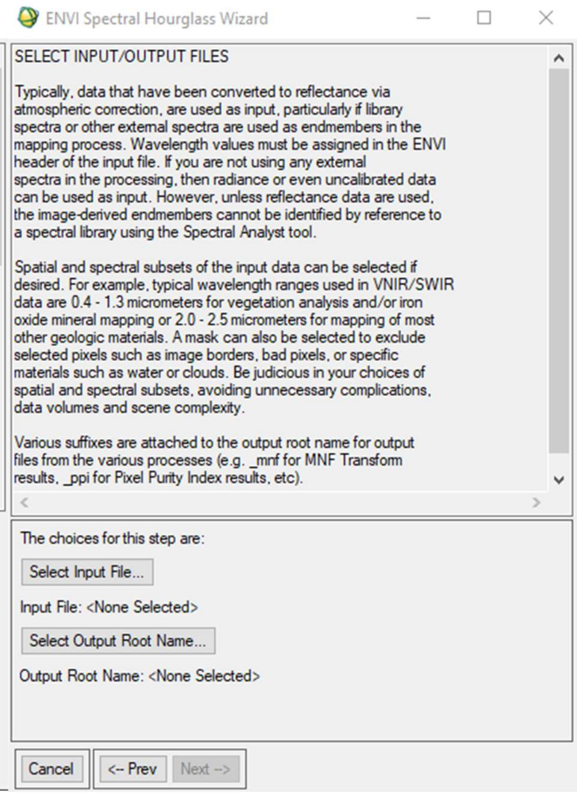
It starts with atmospherically corrected reflectance data.

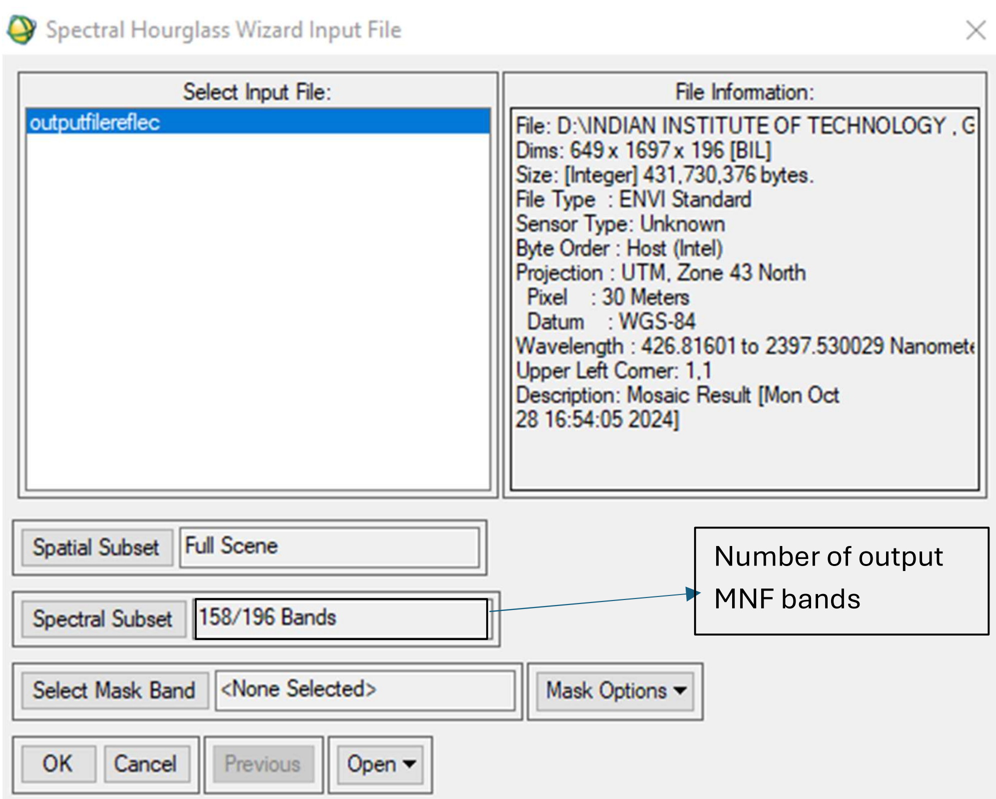
Users can subset, visualize data in n-D space, and cluster pure pixels into endmembers or input their own.

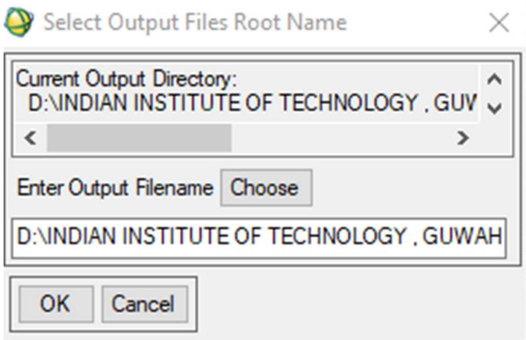
The flow maps endmember distribution and abundance.



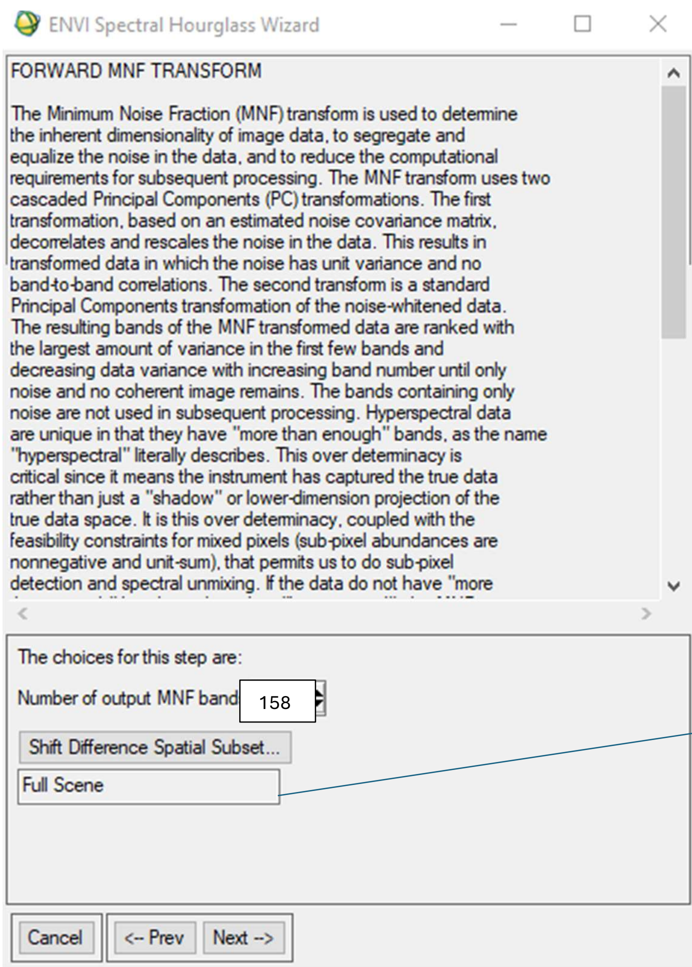

ENVI Spectral Hourglass Wizard
INTRODUCTION
Welcome to the ENVI Spectral Hourglass Wizard. This Wizard leads you through the ENVI hourglass processing flow to automatically find and map image spectral endmembers from hyperspectral or multispectral data. The hourglass processing flow leverages the unique spectrally over determined nature of hyperspectral data, permitting sub-pixel target detections, material identification and unambiguous spectral unmixing. The processing steps performed by this Wizard are:
1. Input/Output File Selection (input data are usually in reflectance)
2. MNF Transformation to reduce spectral dimensions
3. Review of MNF Results
4. Data Dimensionality determination using Spatial Coherence measures
5. Pixel Purity Index (PPI) to reduce spatial dimensions
6. Review of PPI Results
7. n-Dimensional Visualization, including auto-clustering, to select and retrieve individual endmembers
8. The option to manually add User Supplied Endmembers
9. Spectral mapping using Spectral Angle Mapper (SAM) and/or Mixture-Tuned Matched Filtering (MTMF)
10. Investigation of Mapping Results
Cancel
<-- Prev
Next -->


ENVI Spectral Hourglass Wizard
SELECT INPUT/OUTPUT FILES
Typically, data that have been converted to reflectance via atmospheric correction, are used as input, particularly if library spectra or other external spectra are used as endmembers in the mapping process. Wavelength values must be assigned in the ENVI header of the input file. If you are not using any external spectra in the processing, then radiance or even uncalibrated data can be used as input. However, unless reflectance data are used, the image-derived endmembers cannot be identified by reference to a spectral library using the Spectral Analyst tool.
Spatial and spectral subsets of the input data can be selected if desired. For example, typical wavelength ranges used in VNIR/SWIR data are 0.4 - 1.3 micrometers for vegetation analysis and/or iron oxide mineral mapping or 2.0 - 2.5 micrometers for mapping of most other geologic materials. A mask can also be selected to exclude selected pixels such as image borders, bad pixels, or specific materials such as water or clouds. Be judicious in your choices of spatial and spectral subsets, avoiding unnecessary complications, data volumes and scene complexity.
Various suffixes are attached to the output root name for output files from the various processes (e.g. _mnf for MNF Transform results, _ppi for Pixel Purity Index results, etc).
The choices for this step are:
Select Input File...
Input File: <None Selected>
Select Output Root Name...
Output Root Name: <None Selected>
Cancel
<-- Prev
Next -->

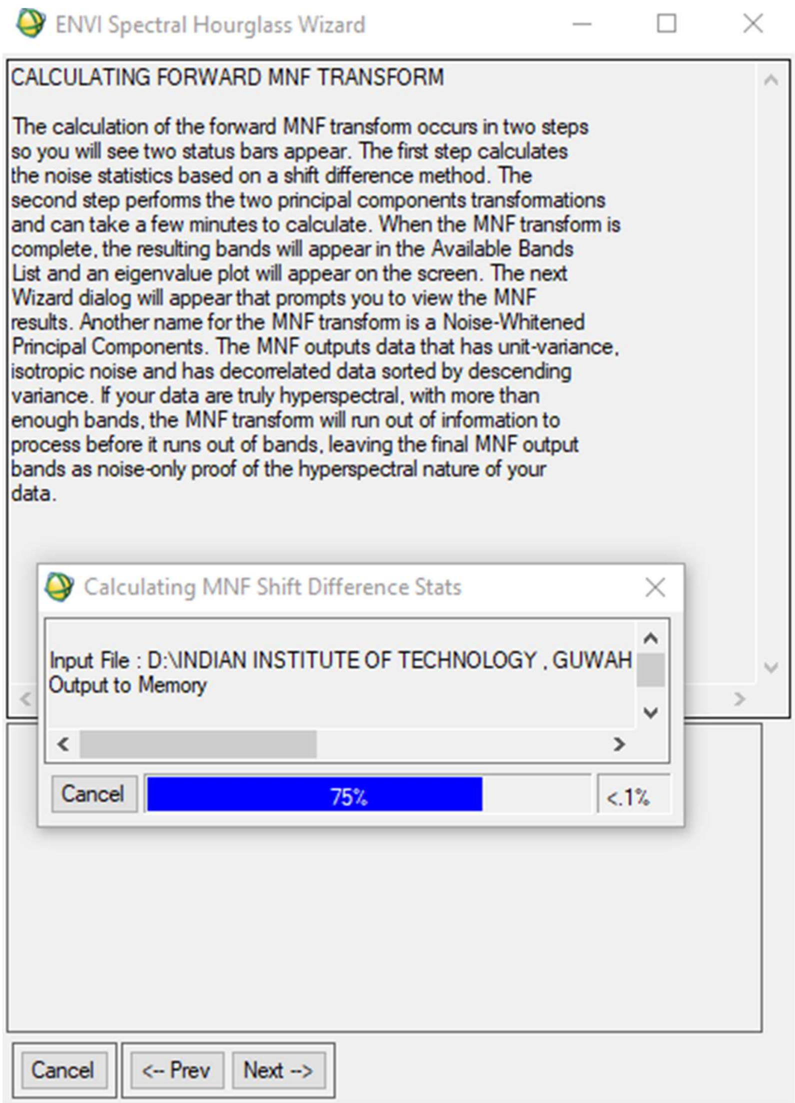

Spectral Hourglass Wizard Input File
Select Input File:
outputfilereflec
File Information:
File: D:\INDIAN INSTITUTE OF TECHNOLOGY , G
Dims: 649 x 1697 x 196 [BIL]
Size: [Integer] 431,730,376 bytes.
File Type : ENVI Standard
Sensor Type: Unknown
Byte Order : Host (Intel)
Projection : UTM, Zone 43 North
Pixel : 30 Meters
Datum : WGS-84
Wavelength : 426.81601 to 2397.530029 Nanomete
Upper Left Corner: 1,1
Description: Mosaic Result [Mon Oct 28 16:54:05 2024]
Spatial Subset
Full Scene
Spectral Subset
158/196 Bands
Number of output MNF bands
Select Mask Band
<None Selected>
Mask Options
OK
Cancel
Previous
Open



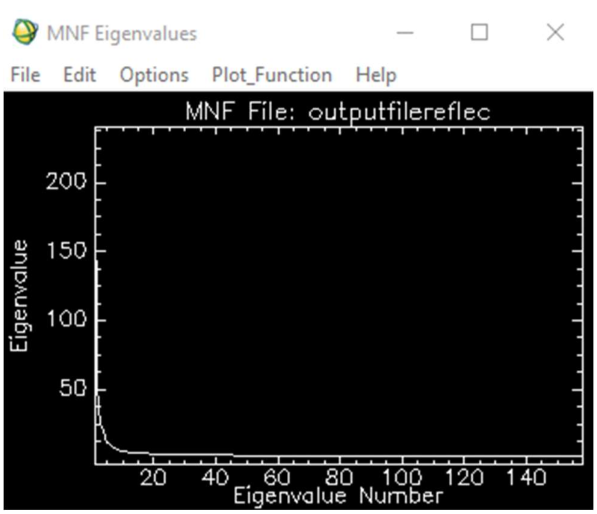
Forward MNF Transform



Shift difference method that uses local pixel variance to estimate noise



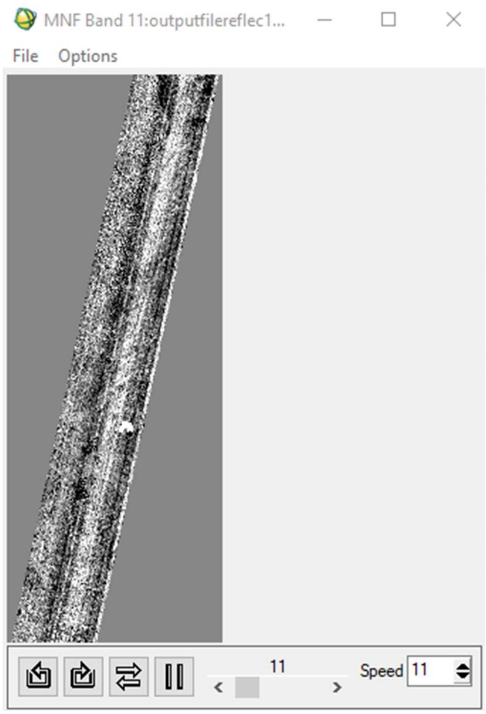
MNF Eigenvalues plot

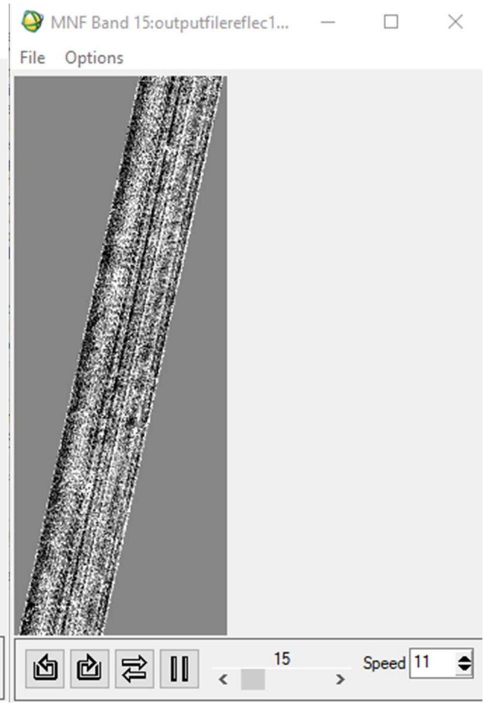


Larger eigenvalues indicate higher data variance in the transformed band and may help to indicate data dimensionality.

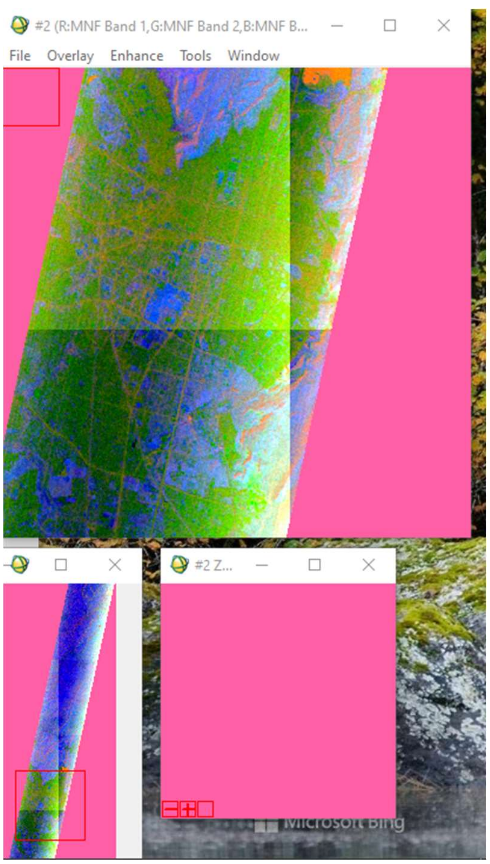
This graph shows MNF Band value gets poorer from BAND 15 and onwards .

MNF result as a gray scale animation

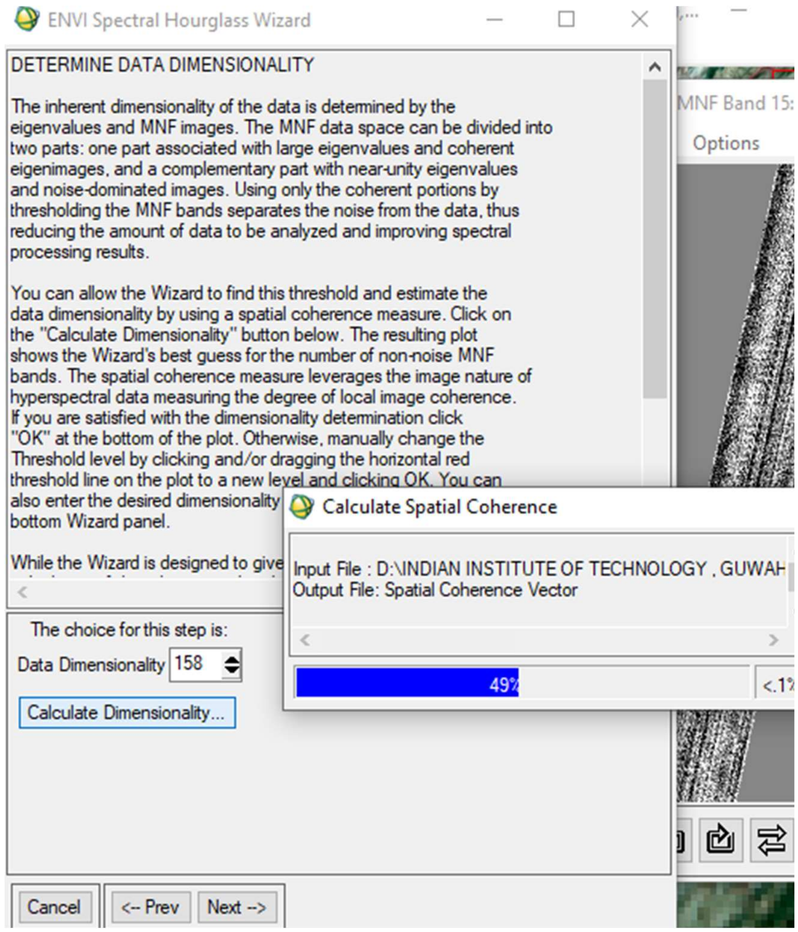


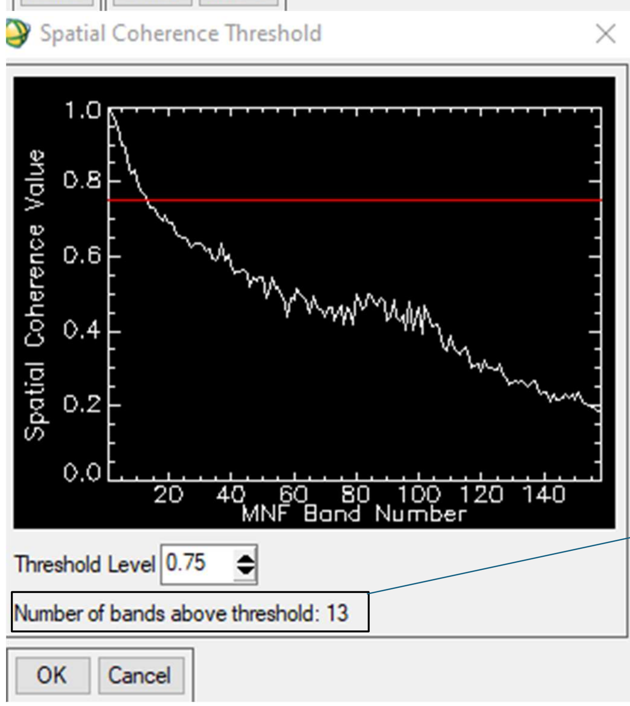


Output MNF Band



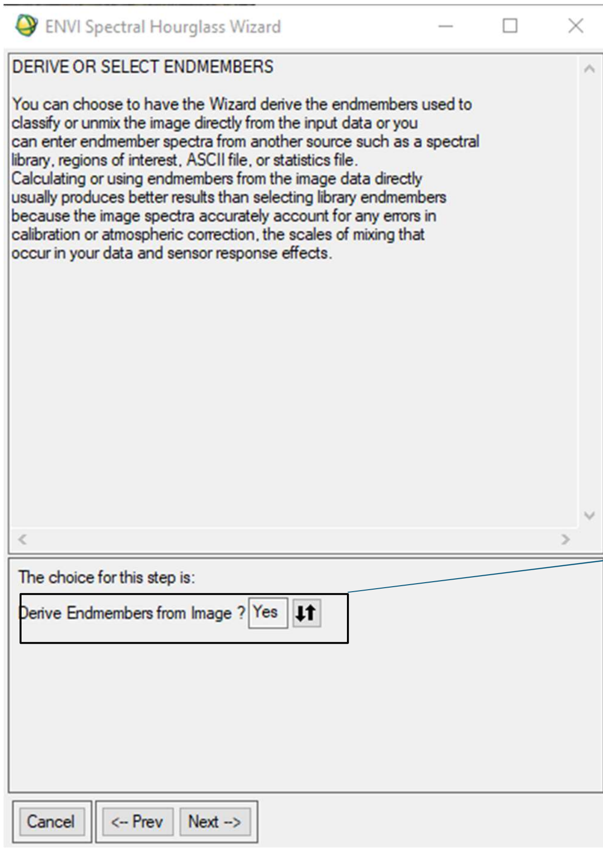
Data dimensionality





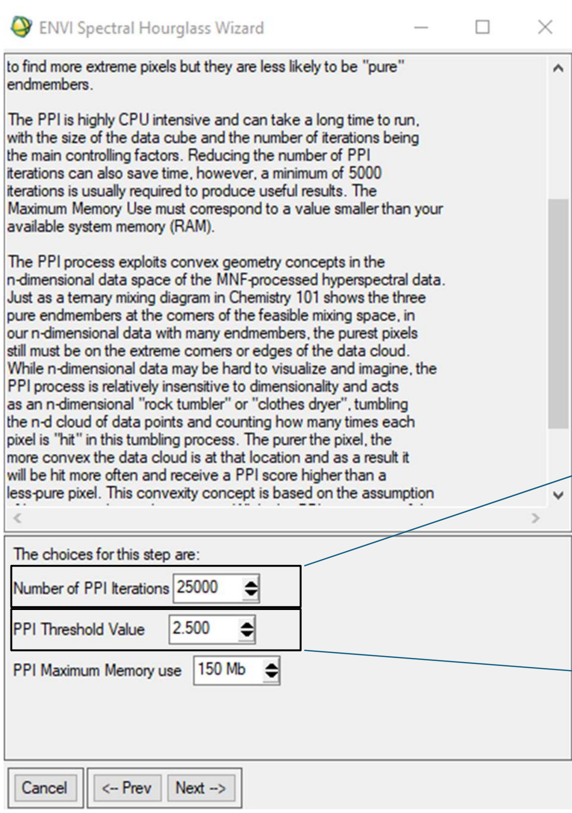
The lower MNF bands are expected to have spatial structure and contain most of the information, while higher MNF bands are expected to have little spatial structure and contain most of the noise.

By retaining only, the coherent MNF bands and discarding those that are indistinguishable from the noise, the data set is reduced to its inherent dimensionality. This should improve spectral processing results.



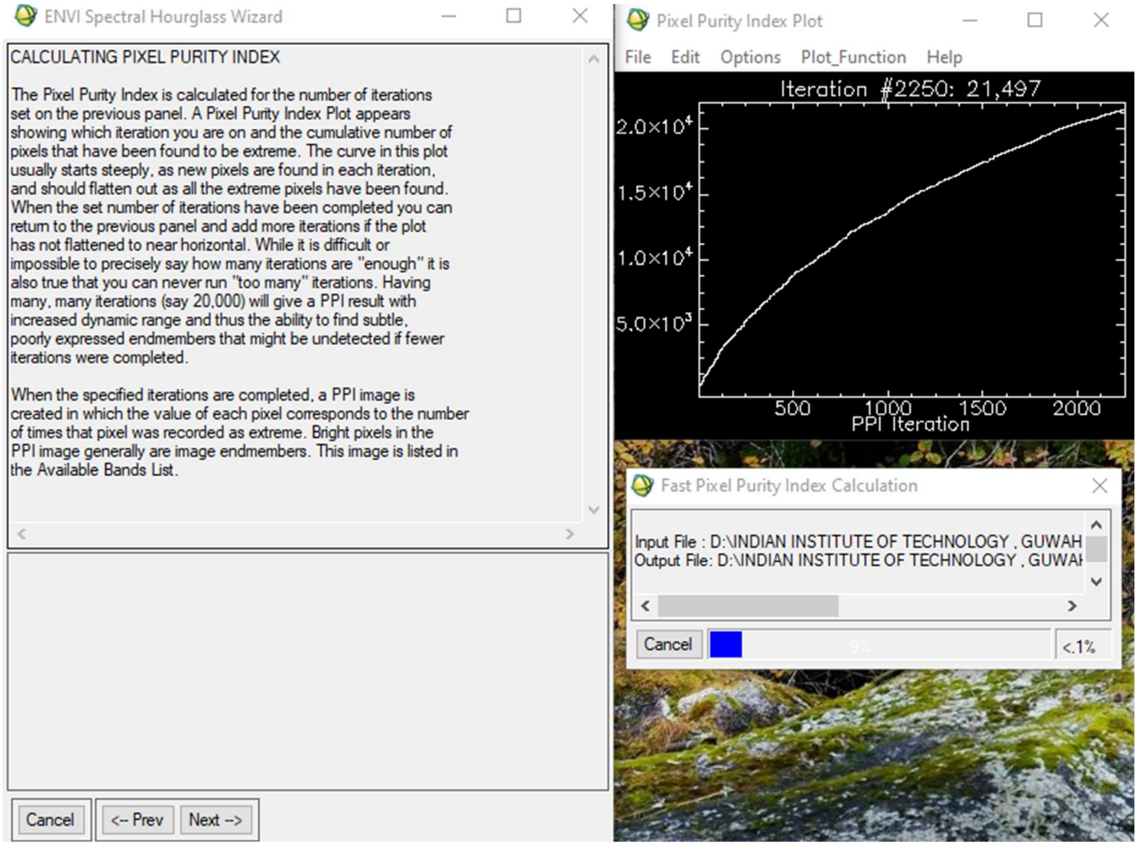
This step to helps derive the end member from the Input Image)

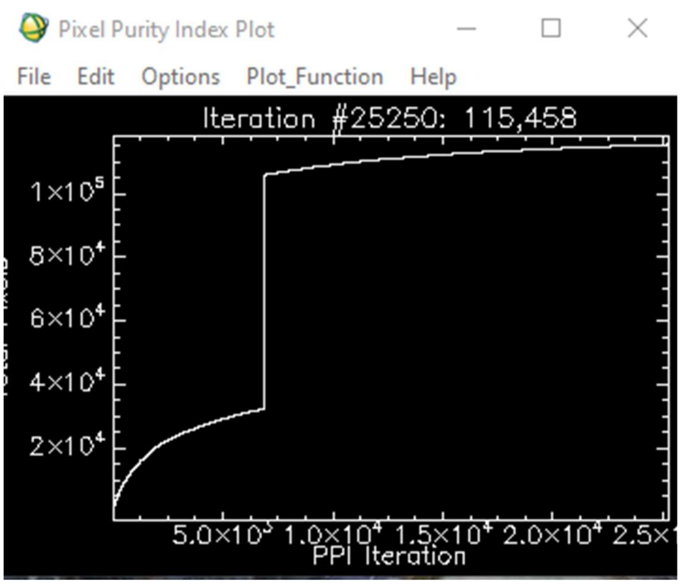
Pixel Purity Index



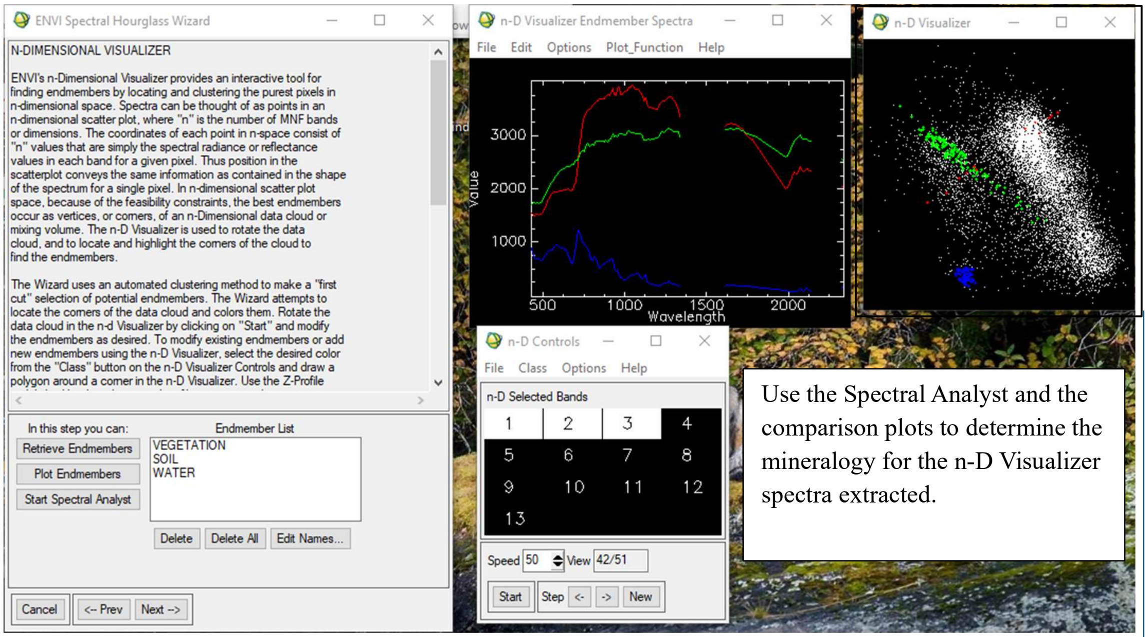
The PPI is highly CPU-intensive and can take a long time to run, with the size of the data cube and the number of iterations being the main controlling factors. A minimum of 5,000 iterations is usually required to produce useful results

The PPI Threshold Value is used to define how many pixels are marked as extreme at the ends of the projected vector.

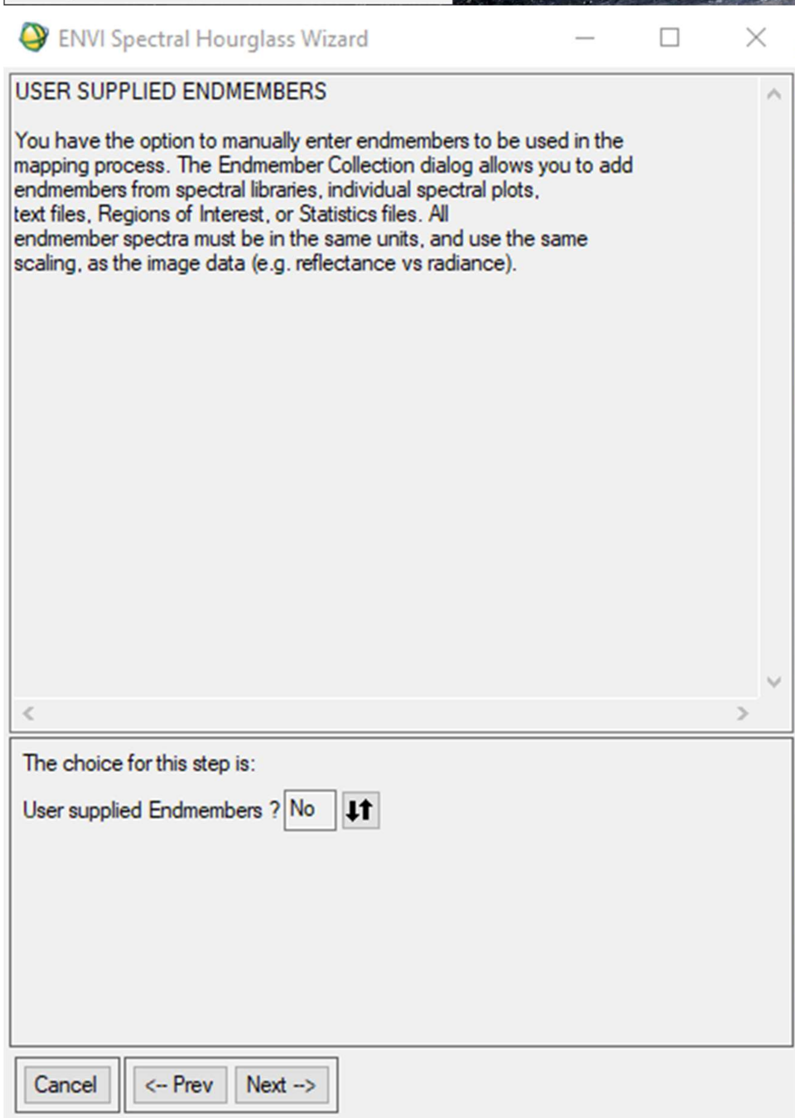




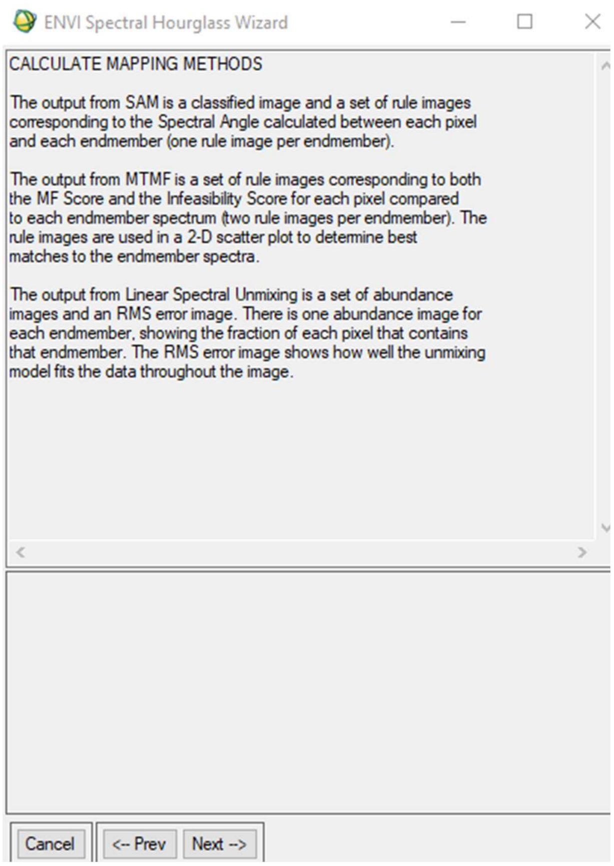
The curve in this plot usually starts steeply, as new pixels are found in each iteration

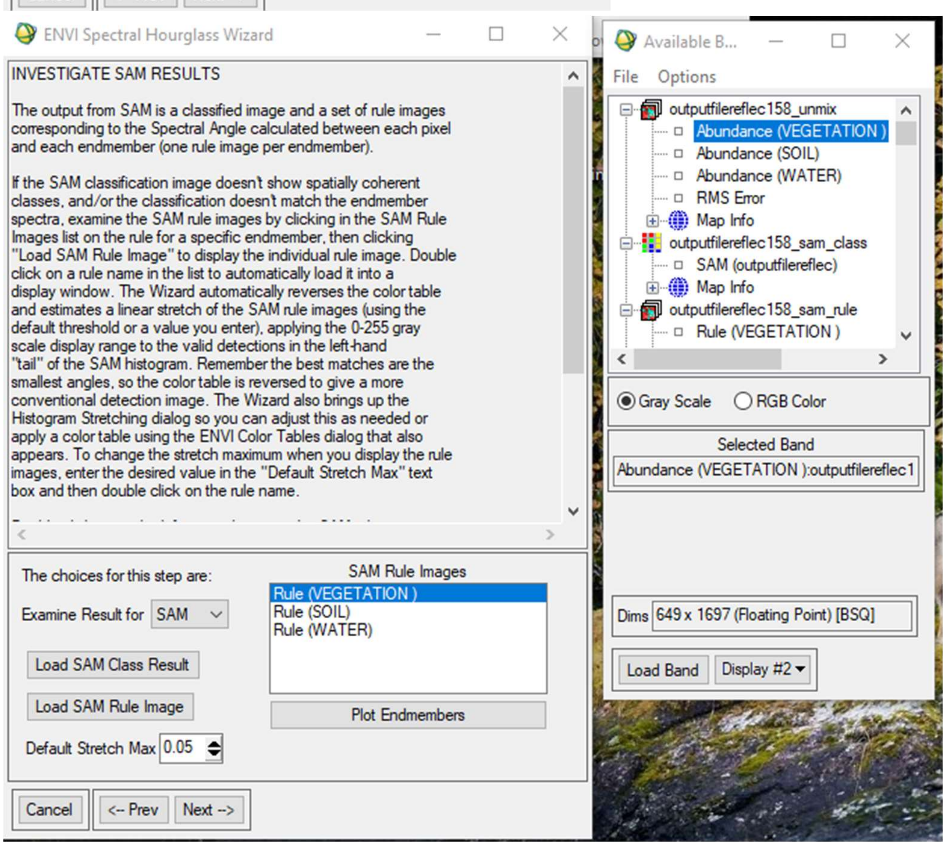


Use the Spectral Analyst and the comparison plots to determine the mineralogy for the n-D Visualizer spectra extracted.



N-D visualizer and control helps to locate, identify, and cluster the purest pixels and most extreme spectral responses in a data set (PPI image)


ENVI Spectral Hourglass Wizard
CALCULATE MAPPING METHODS
The output from SAM is a classified image and a set of rule images corresponding to the Spectral Angle calculated between each pixel and each endmember (one rule image per endmember).
The output from MTMF is a set of rule images corresponding to both the MF Score and the Infeasibility Score for each pixel compared to each endmember spectrum (two rule images per endmember). The rule images are used in a 2-D scatter plot to determine best matches to the endmember spectra.
The output from Linear Spectral Unmixing is a set of abundance images and an RMS error image. There is one abundance image for each endmember, showing the fraction of each pixel that contains that endmember. The RMS error image shows how well the unmixing model fits the data throughout the image.
Cancel
<-- Prev
Next -->

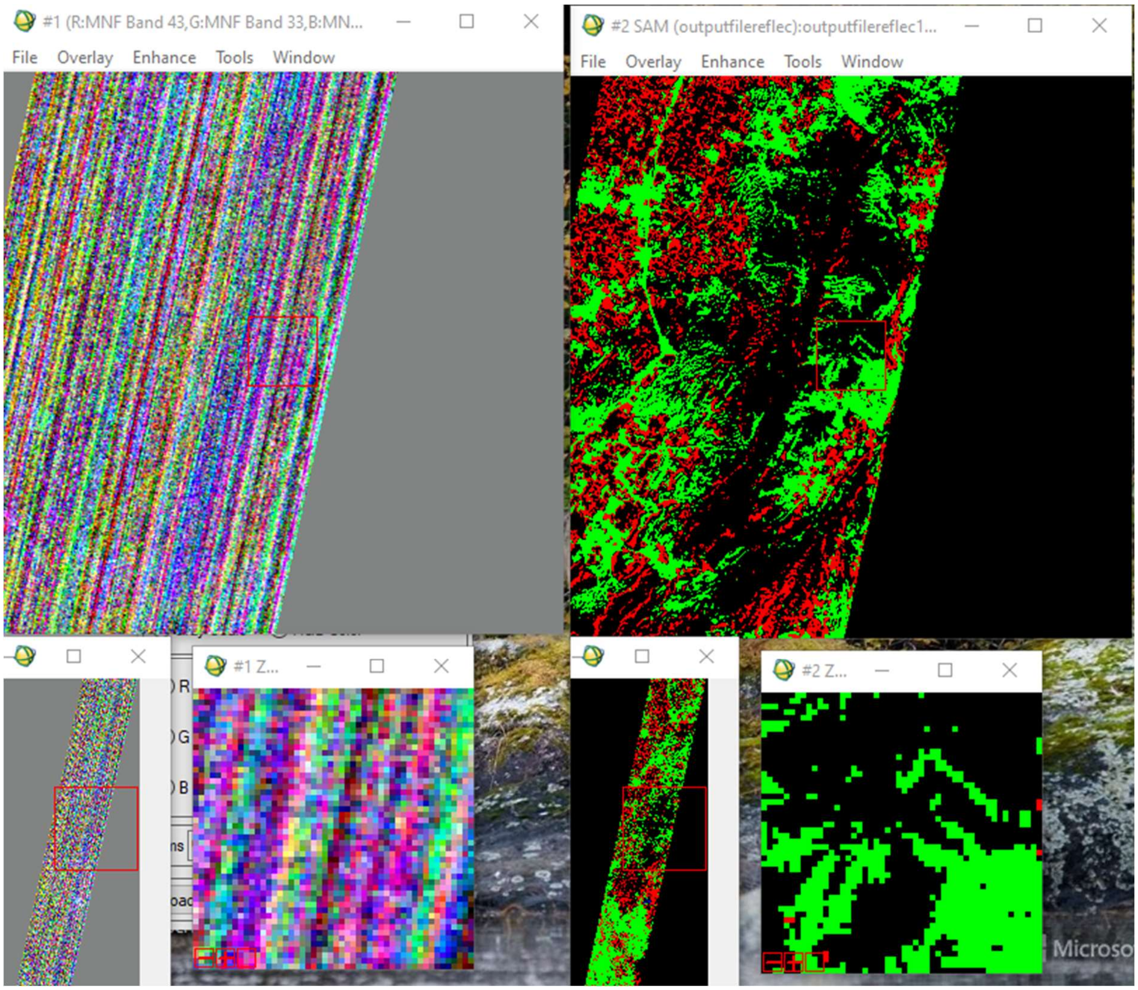

ENVI Spectral Hourglass Wizard
INVESTIGATE SAM RESULTS
The output from SAM is a classified image and a set of rule images corresponding to the Spectral Angle calculated between each pixel and each endmember (one rule image per endmember).
If the SAM classification image doesn't show spatially coherent classes, and/or the classification doesn't match the endmember spectra, examine the SAM rule images by clicking in the SAM Rule Images list on the rule for a specific endmember, then clicking "Load SAM Rule Image" to display the individual rule image. Double click on a rule name in the list to automatically load it into a display window. The Wizard automatically reverses the color table and estimates a linear stretch of the SAM rule images (using the default threshold or a value you enter), applying the 0-255 gray scale display range to the valid detections in the left-hand "tail" of the SAM histogram. Remember the best matches are the smallest angles, so the color table is reversed to give a more conventional detection image. The Wizard also brings up the Histogram Stretching dialog so you can adjust this as needed or apply a color table using the ENVI Color Tables dialog that also appears. To change the stretch maximum when you display the rule images, enter the desired value in the "Default Stretch Max" text box and then double click on the rule name.
The choices for this step are:
Examine Result for
SAM
Load SAM Class Result
Load SAM Rule Image
Default Stretch Max
0.05
SAM Rule Images
Rule (VEGETATION)
Rule (SOIL)
Rule (WATER)
Plot Endmembers
Cancel
<-- Prev
Next -->
Available B...
File
Options
outputfilereflec158_unmix
Abundance (VEGETATION)
Abundance (SOIL)
Abundance (WATER)
RMS Error
Map Info
outputfilereflec158_sam_class
SAM (outputfilereflec)
Map Info
outputfilereflec158_sam_rule
Rule (VEGETATION)
Gray Scale
RGB Color
Selected Band
Abundance (VEGETATION):outputfilereflec1
Dims
649 x 1697 (Floating Point) [BSQ]
Load Band
Display #2

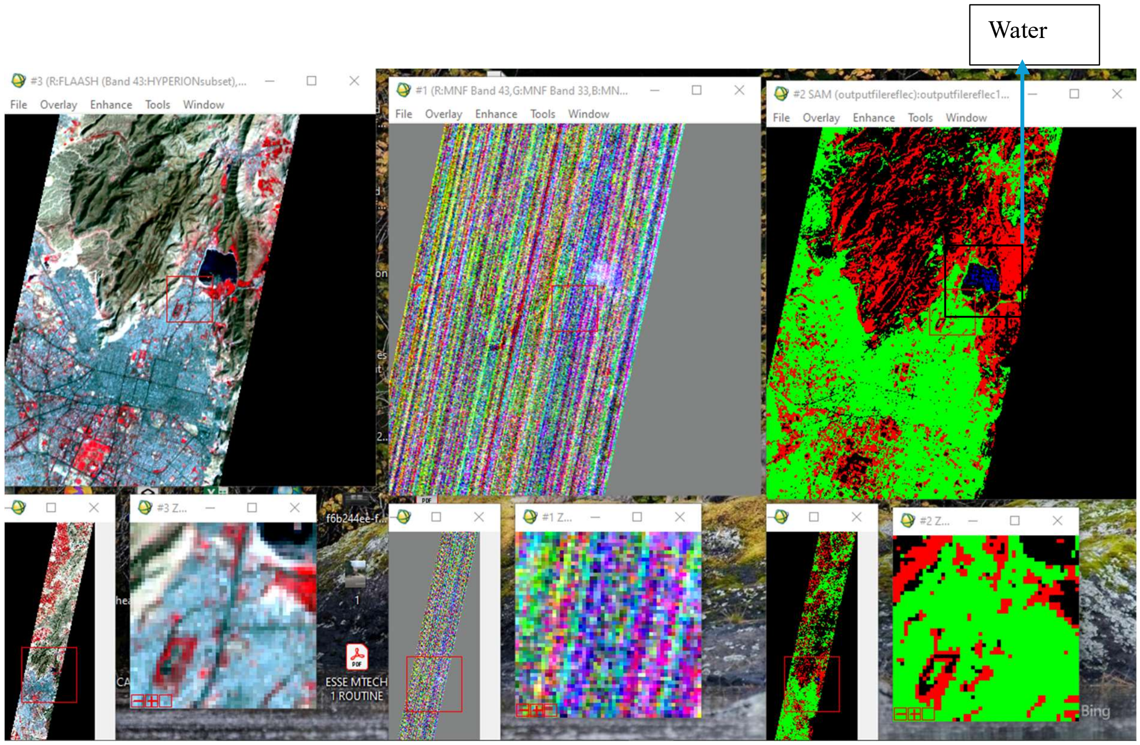
Results

Red – Vegetation

Green – Barren Land

Blue - Water




Water
#3 (R:FLAASH (Band 43:HYPERIONsubset),...
File Overlay Enhance Tools Window
#1 (R:MNF Band 43,G:MNF Band 33,B:MN...
File Overlay Enhance Tools Window
#2 SAM (outputfilereflec):outputfilereflec1...
File Overlay Enhance Tools Window
#3 Z...
#1 Z...
#2 Z...
ESSE MTECH
1 ROUTINE