PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE

UNICA UNIVERSITÀ DEGLI STUDI DI CAGLIARI

ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

ASI Agenzia Spaziale Italiana

INTERNATIONAL REMOTE SENSING SUMMER SCHOOL, III EDITION

Experiencing Remote Sensing on Sardinia inland site: Advanced summer school on instruments and methodology for a CAL/VAL site for Optical data

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Sample UAV HS data classification

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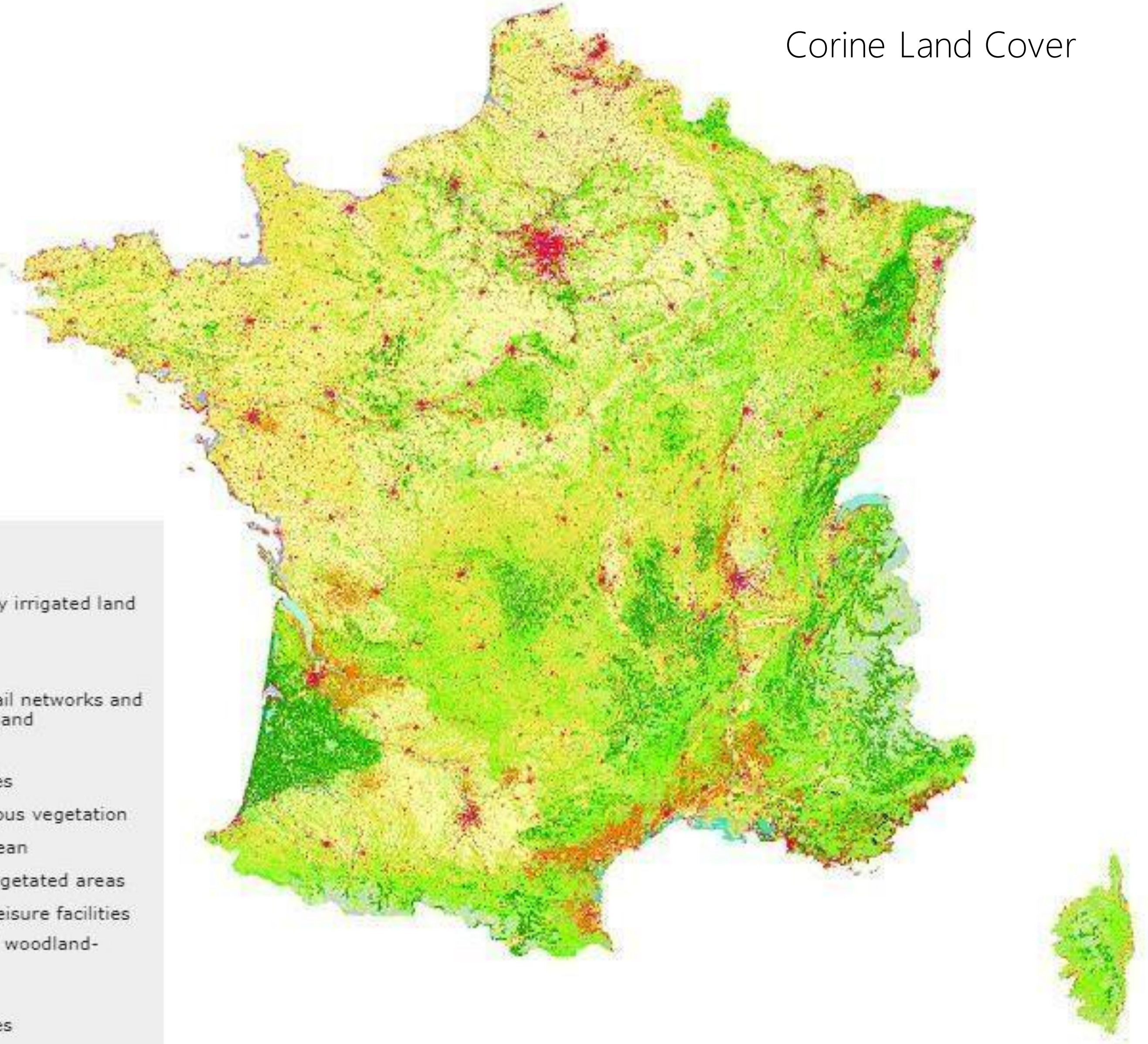
Image classification

- The process of **sorting pixels** into a certain number of classes based on their data values
- Finding **meaningful patterns** in the data (spectral and spatial)
- **Simplify/refine** the interpretation of the RS record

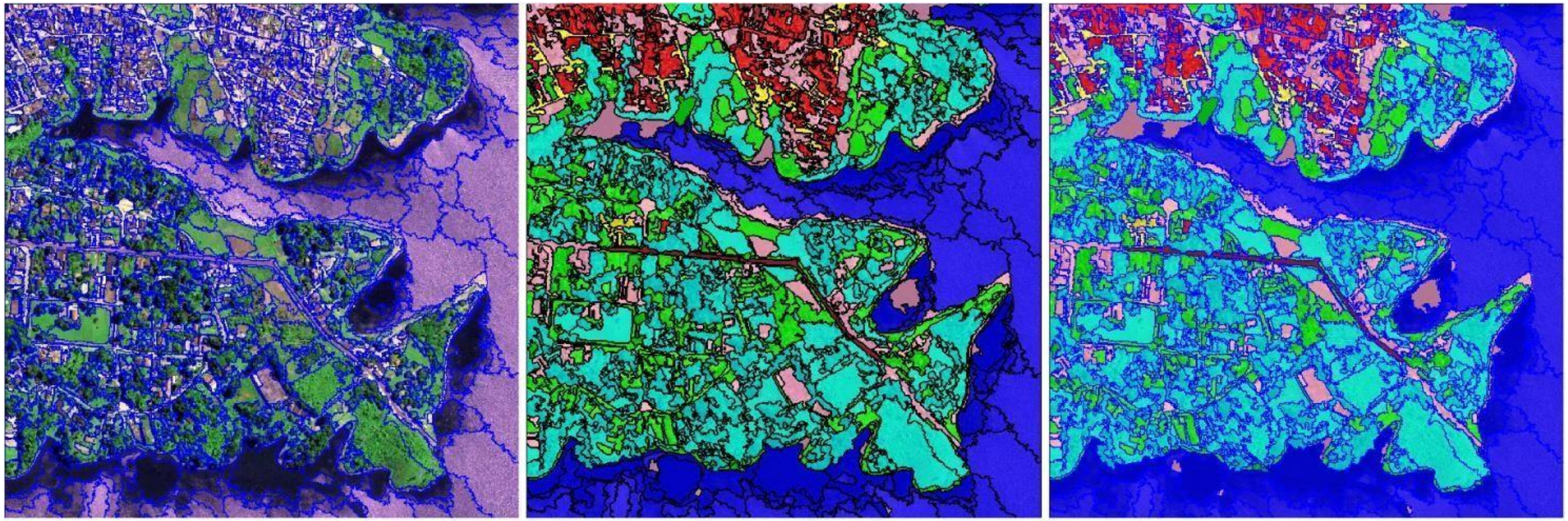
Corine Land Cover



2 approaches

a) Object-oriented (OBIA) (OBIA)

- It uses both spectral information and its spatial distribution



(a) Segmented (b) Classified (c) Region merged

Grass Tree Buildings Water Road Soil

2 approaches

b) Pixel- based (per-pixel)

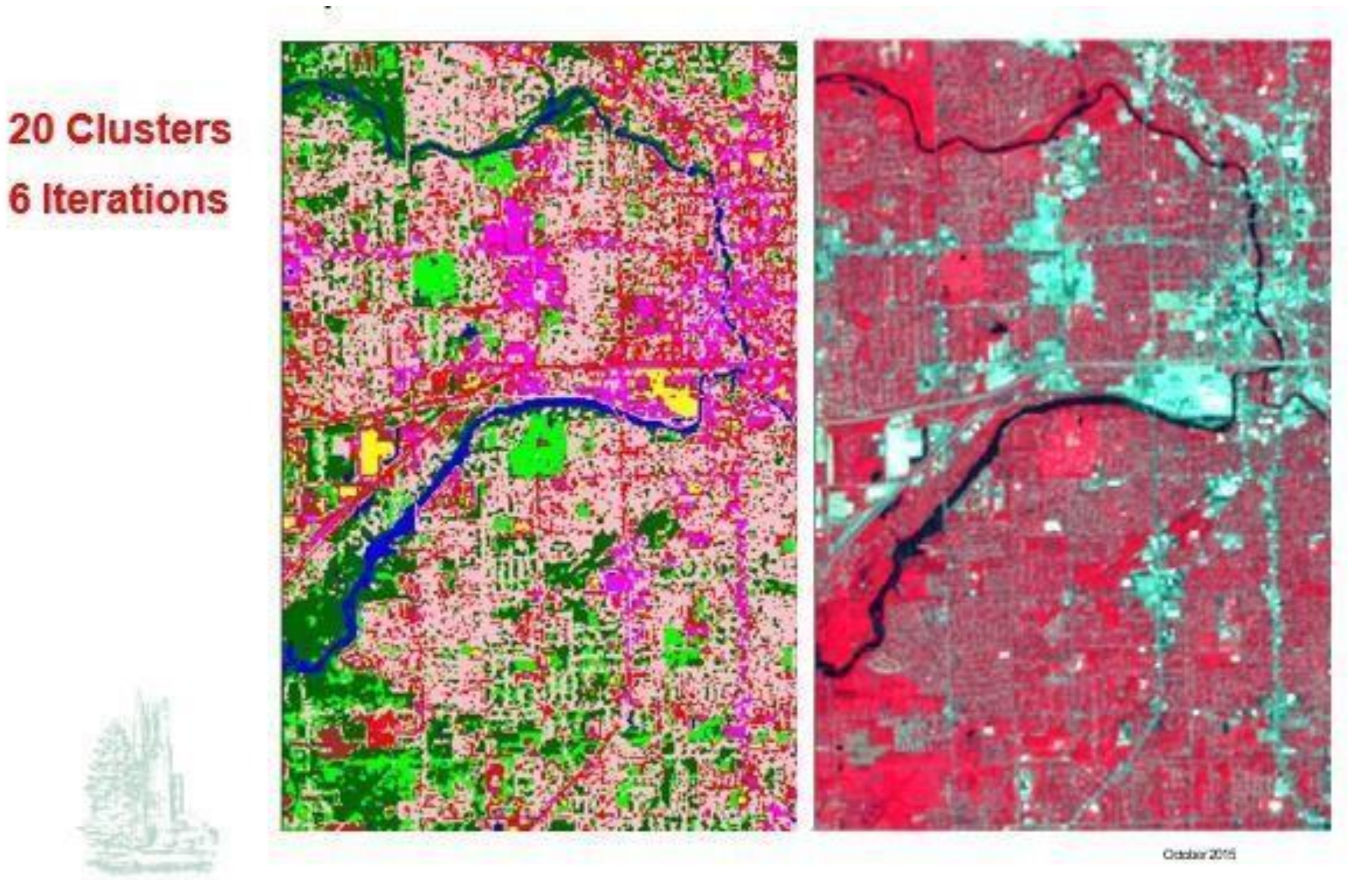
- It uses only spectral information
- It does not use spatial distribution and neighborhood relations

Types:

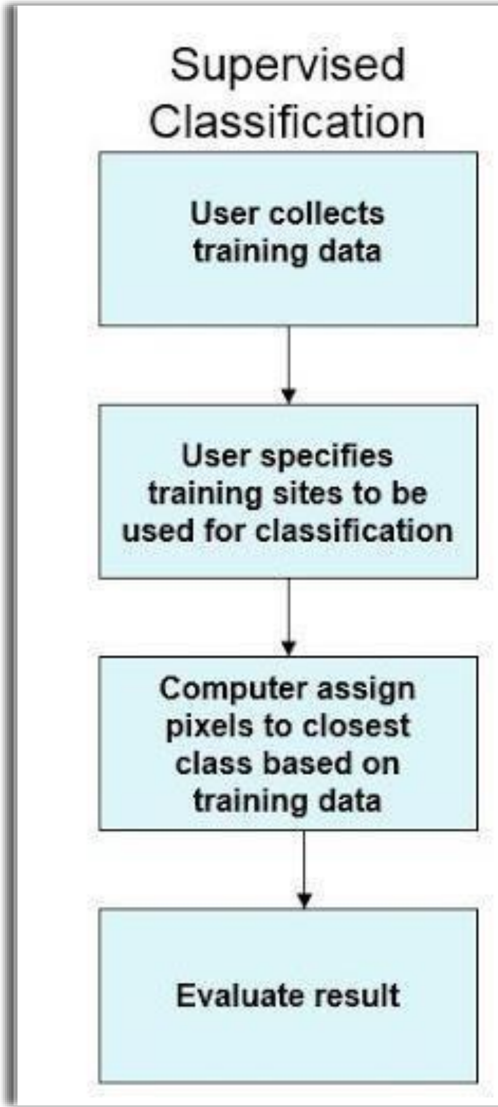
- Supervised classification
- Unsupervised classification
- Based on a different rule

Unsupervised classification

- The raw spectral data are grouped based on the statistical structure of the data only
- Then the computer assigns each statistical cluster into the appropriate class (if possible)



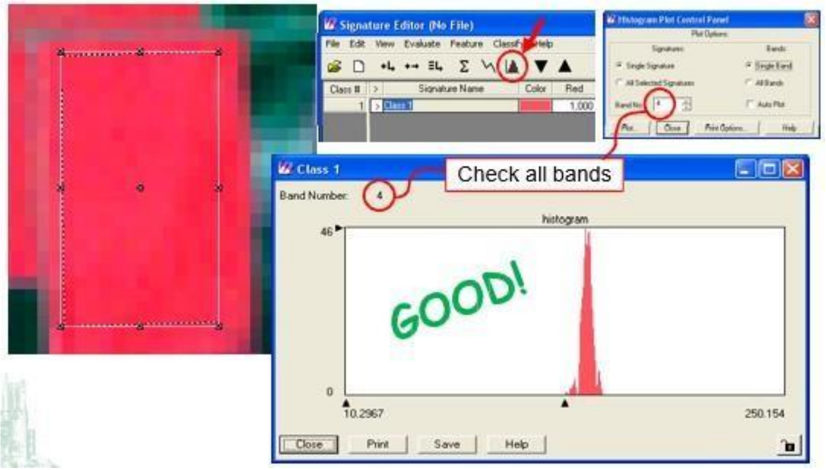
Supervised classification

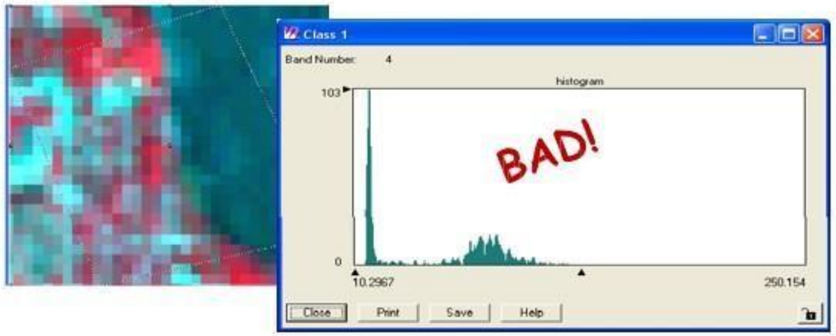


- The user defines homogeneous, representative samples, so-called **training samples** (areas) of different types of land cover

- Based on the selected algorithm, the computer assigns the pixels to the **visually closest class** based on the training areas

- Good **knowledge of the classified area** and good visual interpretation are ideal

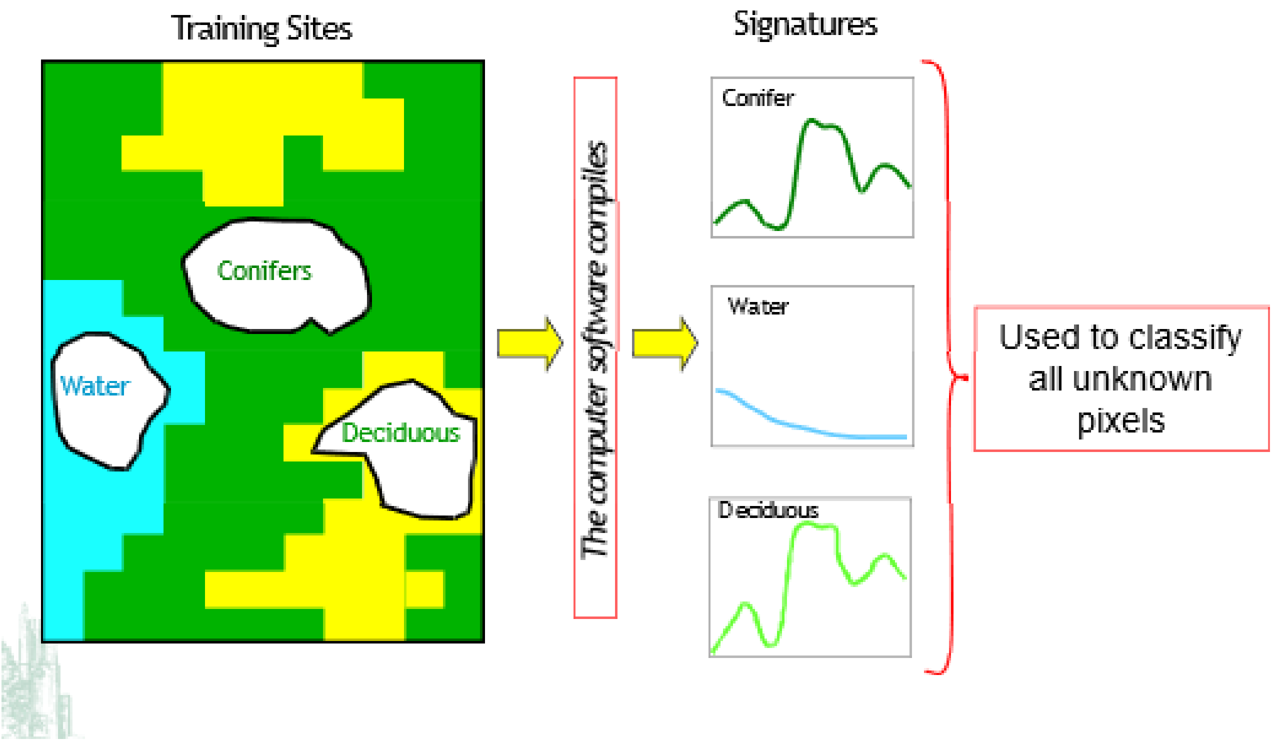




Supervised classification

Types:

- Minimum Distance-to-Means
  – average DN values
- Maximum Likelihood
  – probability of class membership
- Spectral Angle Mapper
  – the minimum angle from the n-dimensional spectral vector of the class



CONTENT OF THIS PRACTICAL

1 Spectral signatures

2 Image classification

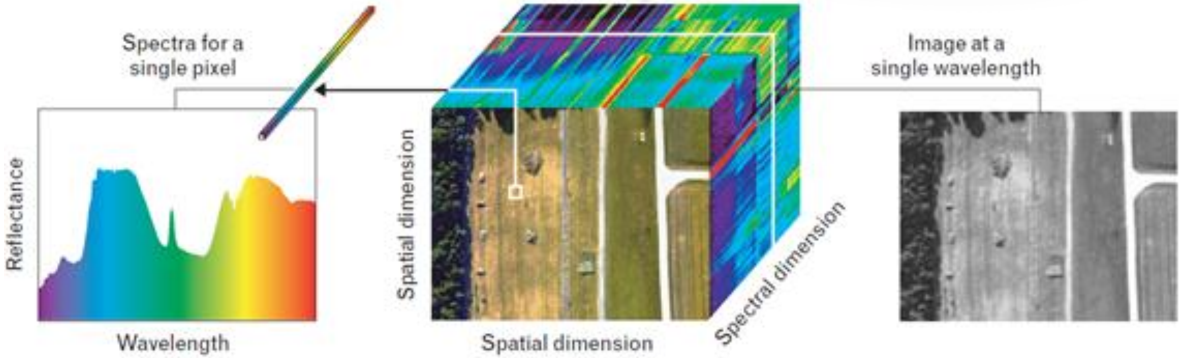
MULTISPEC

INPUT HS DATA

SPECIM
SPECTRAL IMAGING

AISA Kestrel 10

- Push-broom camera, 4.75 kg
- Spatial resolution: 1024 or 2048 pix.
- Spectral range: 400 – 1000 nm
- Max. number of spectral bands: 342



+INPUT LS DATA

- CHM (Canopy Height Model)

- Capture reflected electromagnetic energy in hundreds of contiguous narrow spectral bands
- Combined with UAS:
  - fast, flexible and non-destructive detection of subtle spectral features

MULTISPEC

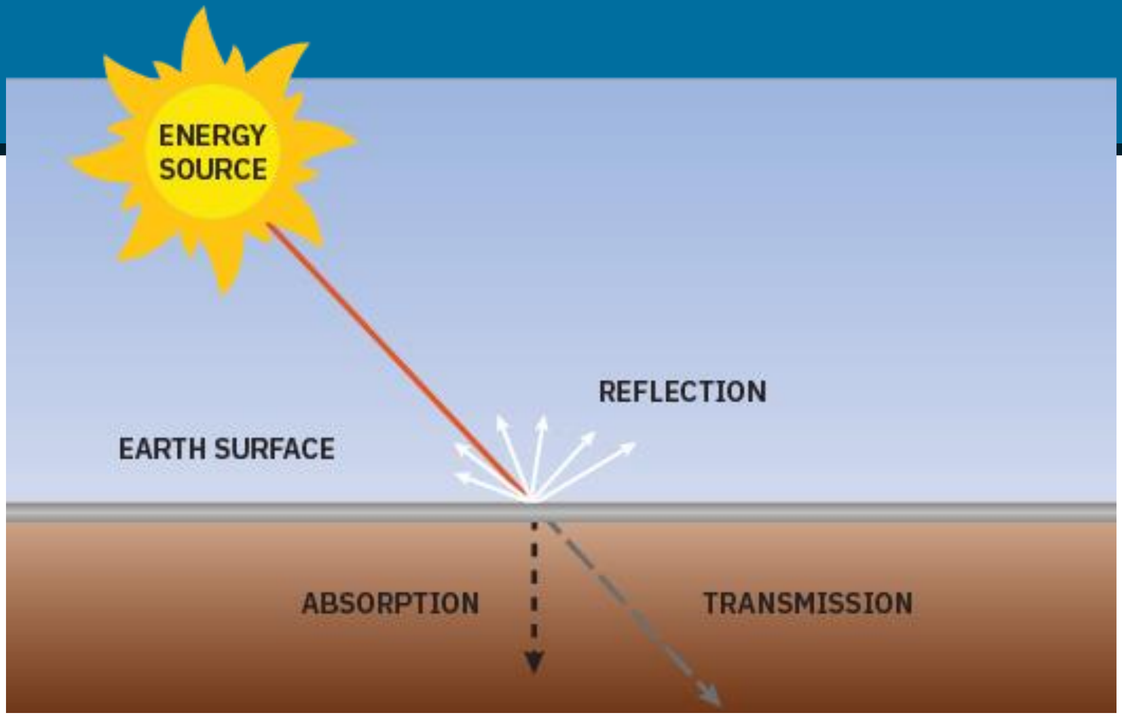
I. SPECTRAL SIGNATURES

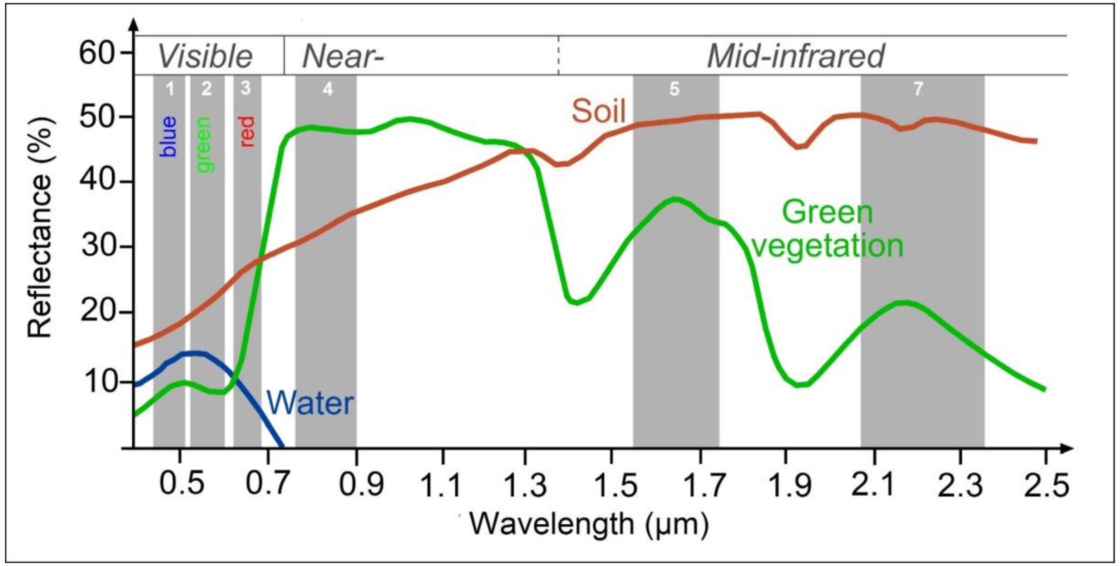
STATE-OF-THE-ART

Spectral signatures and their interpretation

- When EMR from the sun reaches the earth surface, it is:
  - transmitted
  - absorbed
  - reflected

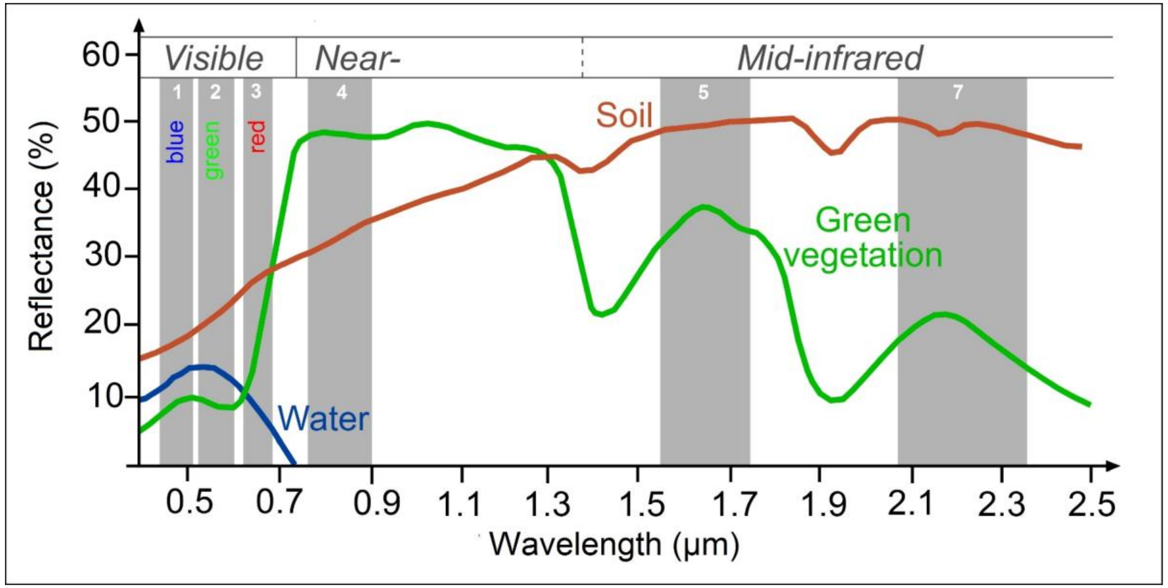
- The nature of how the earth materials transmit, absorb or reflect the solar EMR is called spectral signature of an object





SPECTRA OF EARTH MATERIALS

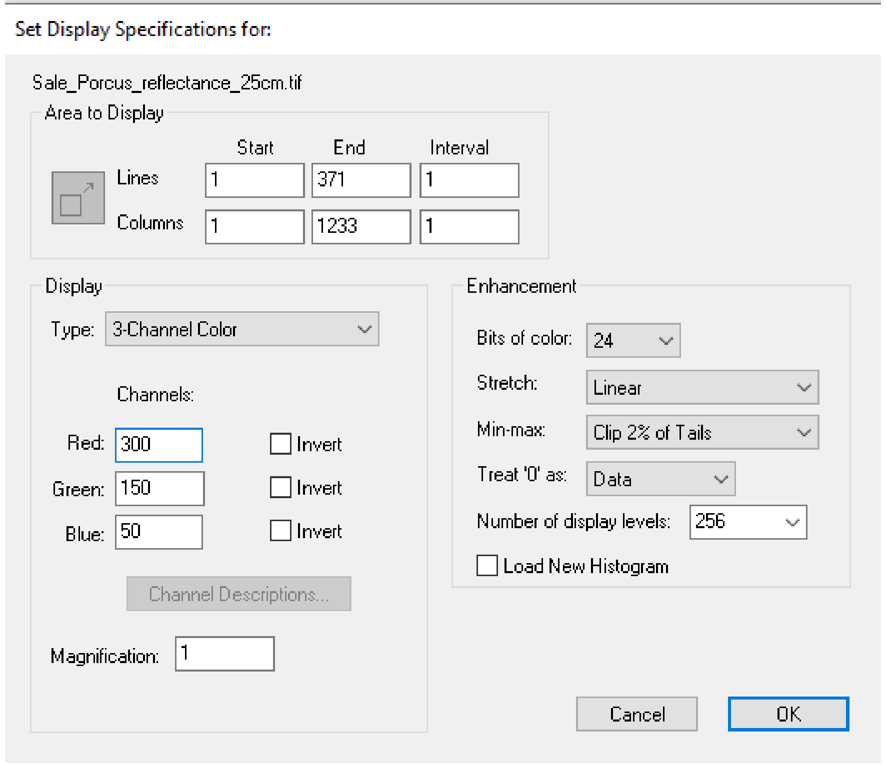
- Objects/surfaces have different combination of transmittance, absorbtion and reflectance in different bands of the spectrum

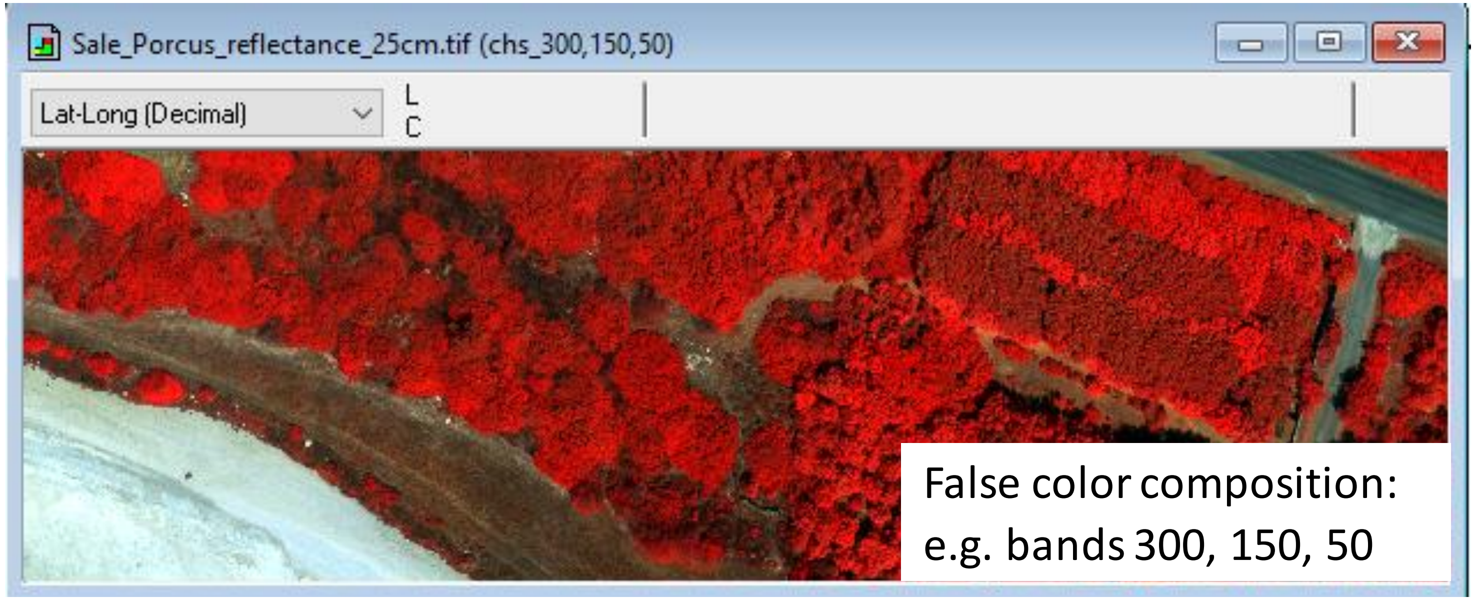


SPECTRA OF EARTH MATERIALS

1.) Data review:

File - Open Image - after selecting the file, a window called Set display specifications opens, which is used to set the visualization parameters of the selected file. In the Channels item, three bands can be selected, which will then be displayed in the form of a color composition (synthesis). It is also possible to edit the image by changing the settings in the Enhancement item.

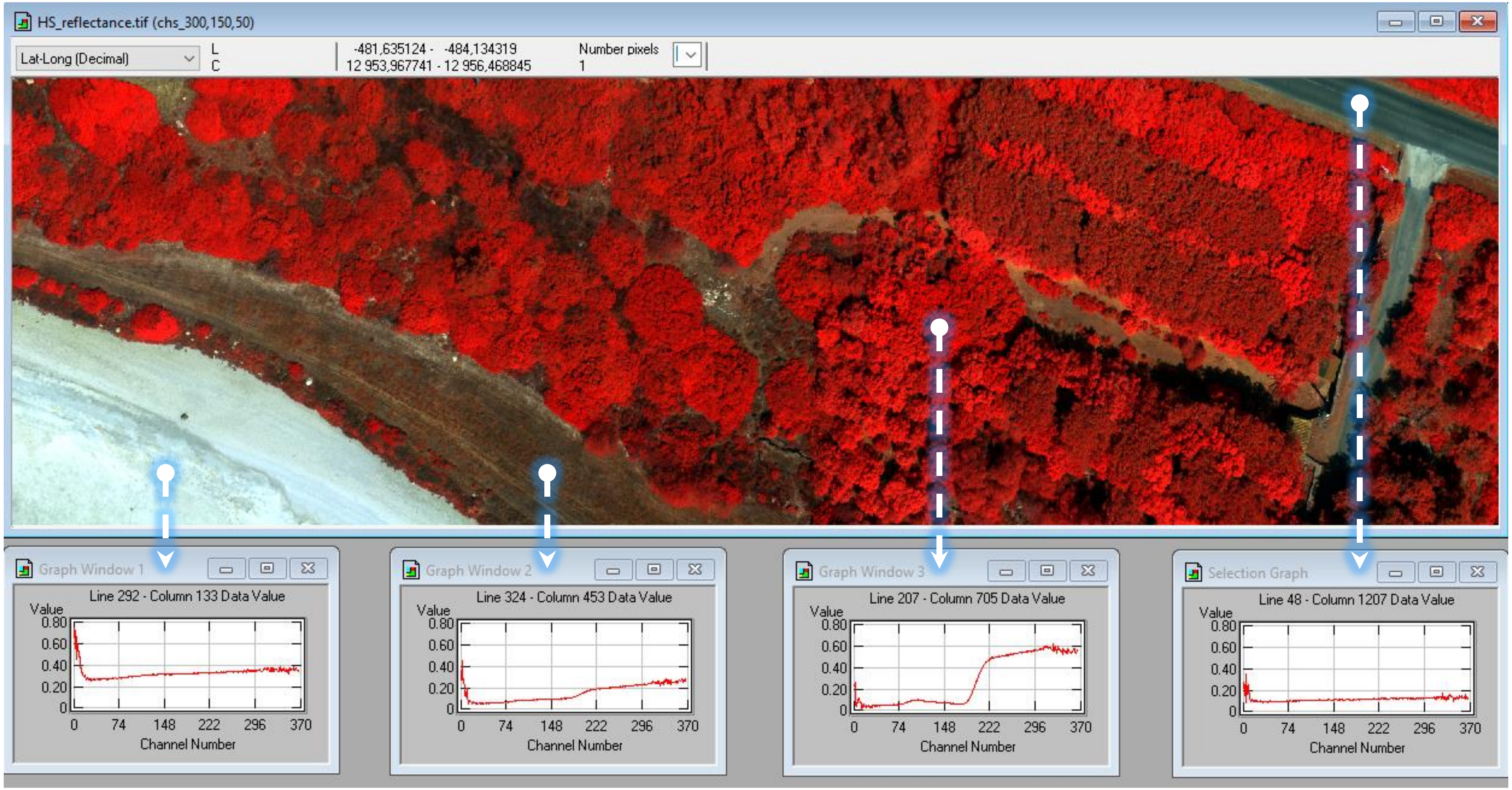




An example of displaying the false color composition using data from the HS scanner AISA KESTREL and the corresponding RGB bands of the scanner.

2.) Display of the spectral curves:

Window – New selection graph



MULTISPEC

II. IMAGE CLASSIFICATION

II.I

MultiSpec

UNSUPERVISED CLASSIFICATION

1. **Open image**

   File - Open Image

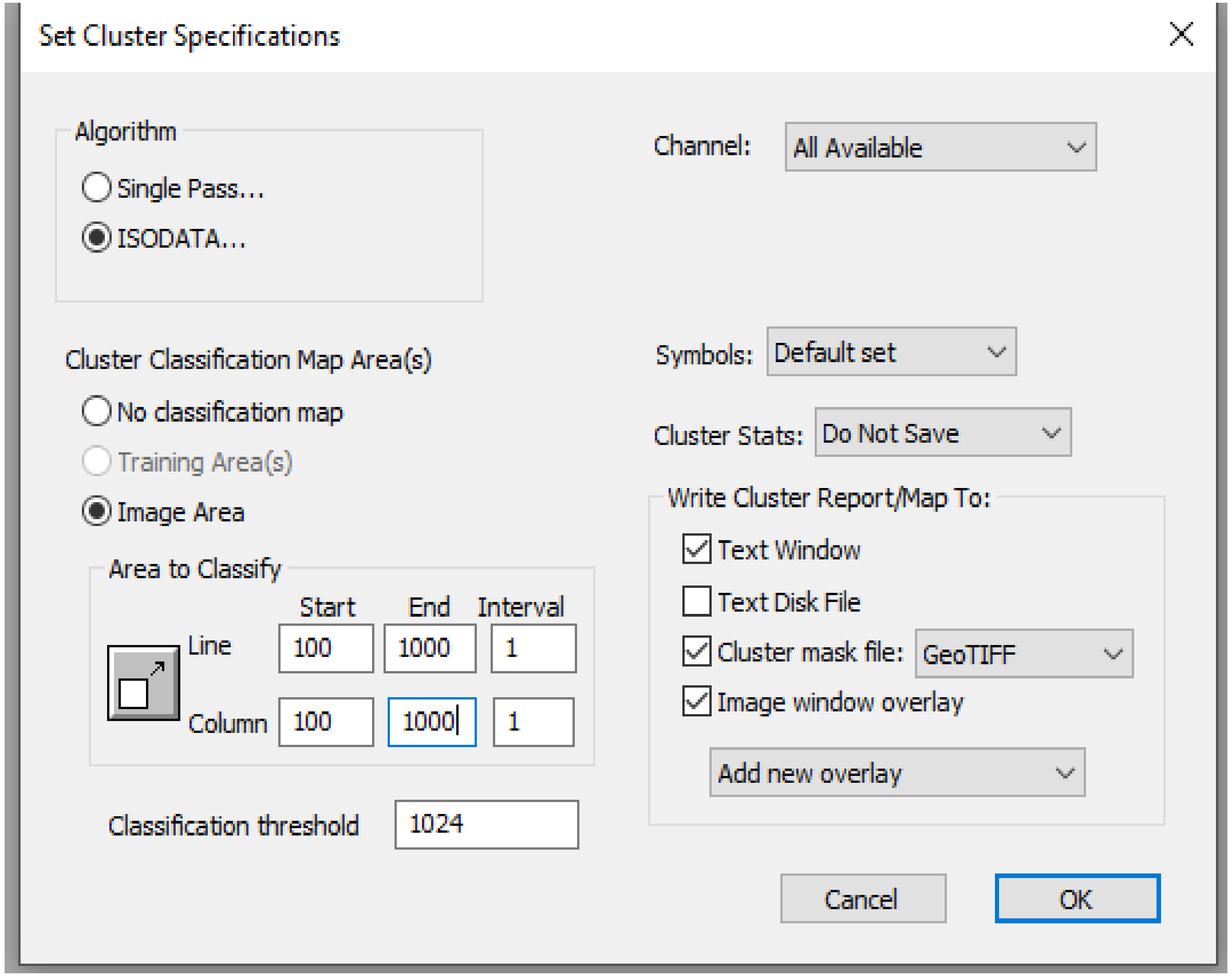
2. **Write Cluster Report/Map to**

   - *Cluster mask file*
   - *Image Window Overlay*

3. **Choose ussupervised classification algorithm:**

   Processor – Cluster – choose algoritm

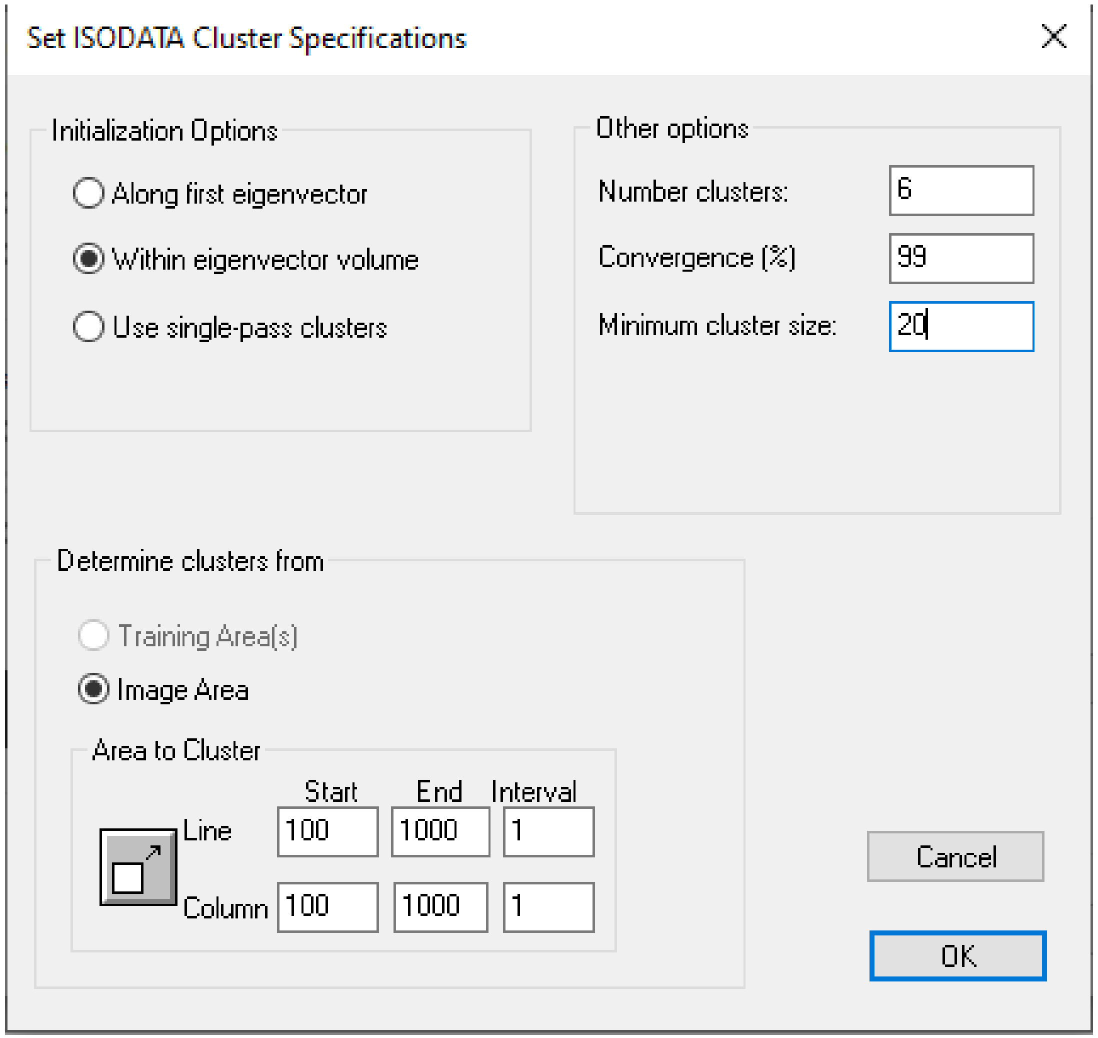
   - ISODATA or Single pass



4. Set ISODATA Cluster specifications:

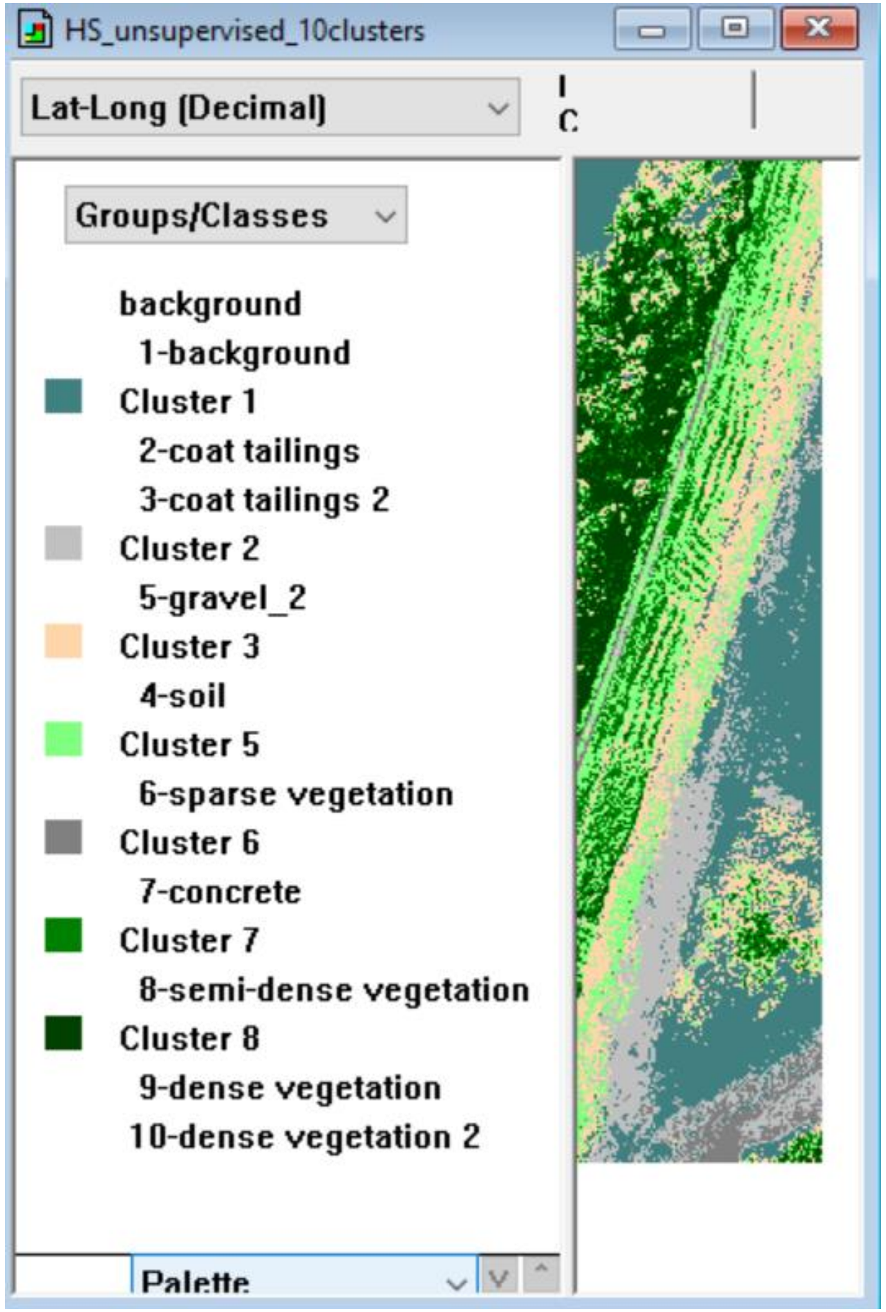
Compared to the Single pass algorithm, you can set the number of clusters (Number clusters) and, similarly to the previous case, the value of the minimum number of pixels forming a cluster (Minimum cluster size). The Convergence (%) parameter affects the number of successive repeated calculations of new cluster centers - iterations. If the number of pixels that do not change their belonging to a certain cluster during the iteration exceeds the specified value, then so-called clusters are created. stable and the calculation is finished.

The method of cluster initialization, which you set in the upper left part of the window (Initialization options), is also important for the classification result. Here you determine how the initial positions of the clusters are to be established in the multidimensional space defined by the individual input bands. The first two options mean that the initial position of the clusters is determined by the principal component analysis method, the third option takes over the result of the single-pass algorithm



5. Editing the result of unsupervised classification

The clustering result is a thematic map stored in the ***.clu fil**e. In the text window of the Multispec program, you will also see the results of the classification in a clear tabular form. Above all, you will find here the resulting number of clusters and the number of pixels included in each of them. Open the saved classification file using the **File – Open Image menu.**



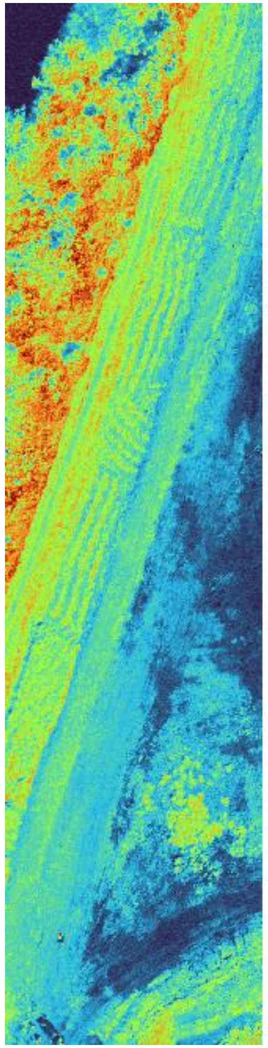
With a larger number of clusters and thus resulting spectral classes, the classified image is difficult to interpret. The colors of individual clusters in the image can be changed by double-clicking on the color icon next to the cluster so that they simulate the color presentation of the selected synthesis. This will make it much easier for you to interpret individual classes, recognize them, or eventually combine (aggregate) several spectral classes (clusters) into categories of basic types of surfaces.

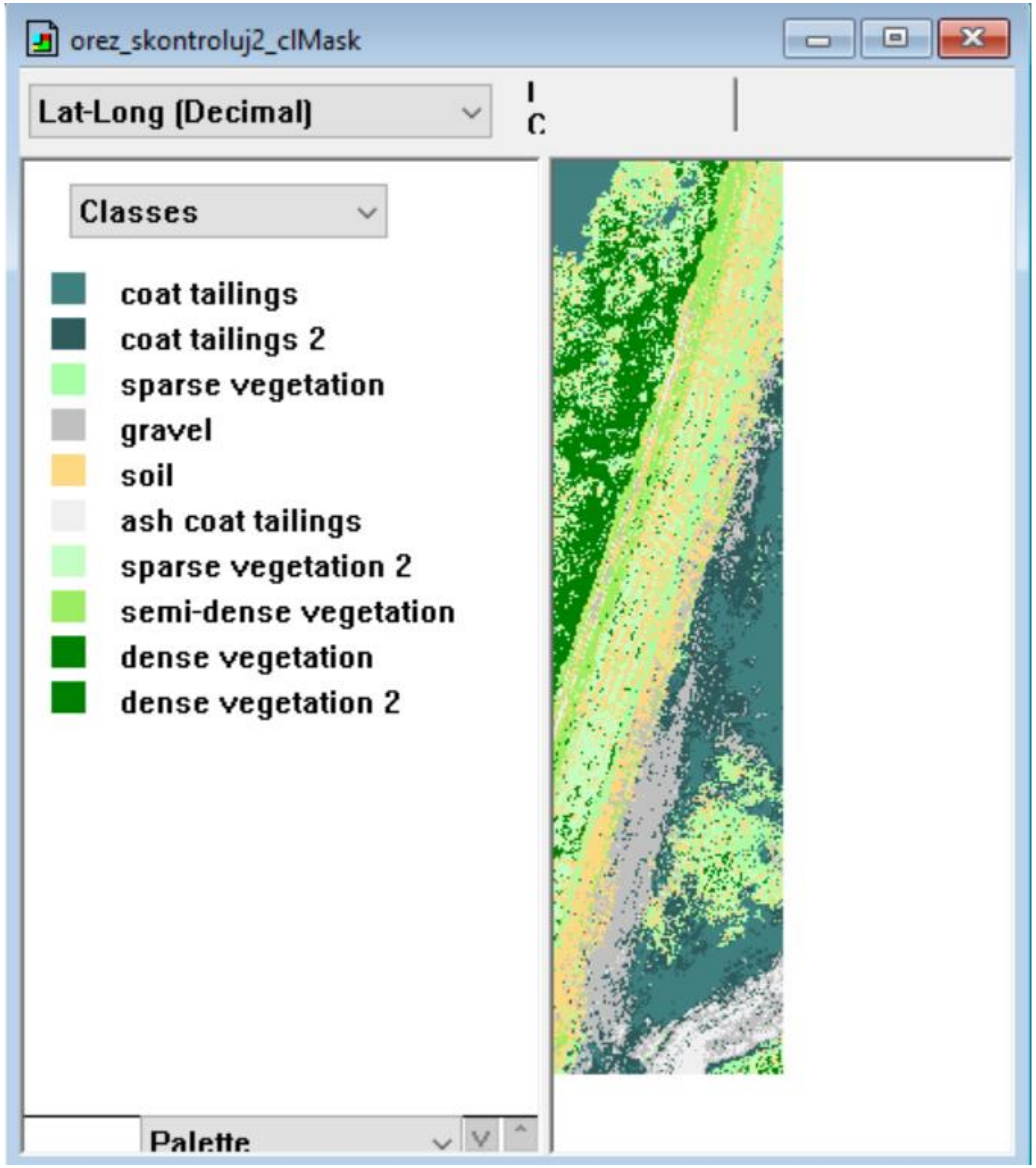
Analogously, you change the name of individual classes by double clicking on the text next to the colored square of the legend.

6. Repeat the process of unsupervised classification with „stacked data" – HS + CHM

HS data

LS data – CHM model





II.II

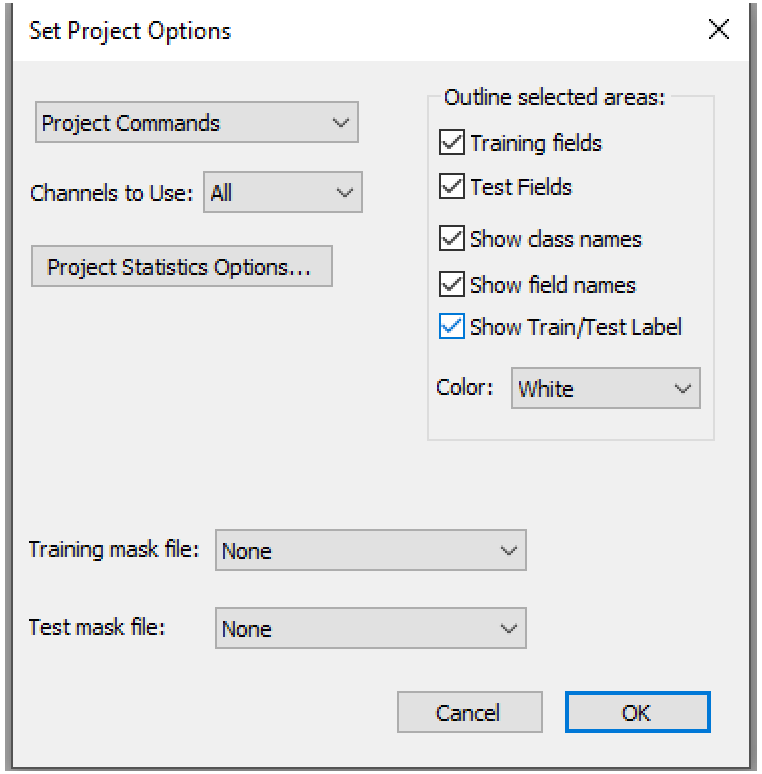
SUPERVISED CLASSIFICATION

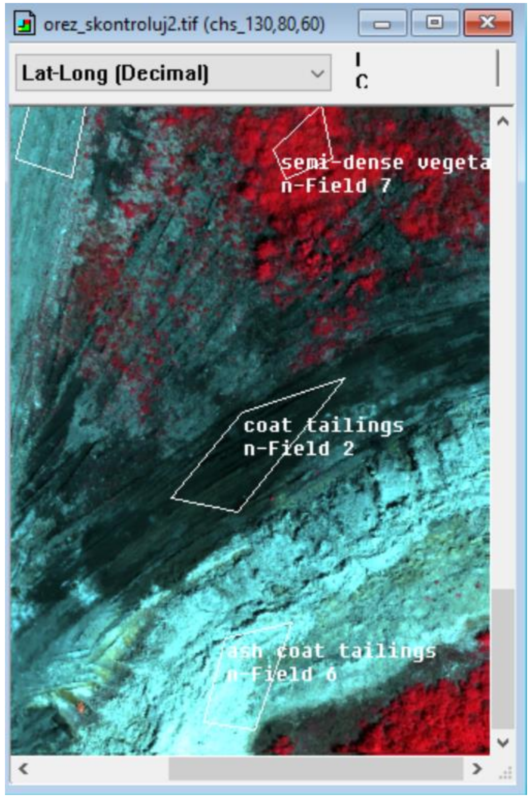
MultiSpec

1. File - Open Image

2. Create training samples (polygons) - ***Processor – Statistics …*** Set Project Options.

In this window, check the item **Show Train/Test Label** and confirm the choice. A new window will open where you can check the **Polygon Enter** option to start creating a training sample for the corresponding land cover type. After creating a training sample (polygon), it is necessary to add the sample to the list via the Add To List option... Via the "New" Class option, we enter the name of the new class, into which other clicked training samples for the same type of land cover will be gradually included. If we want to add a polygon to an already existing class, from the Class drop-down menu we choose the corresponding, already created class, in which we want to include the sample.

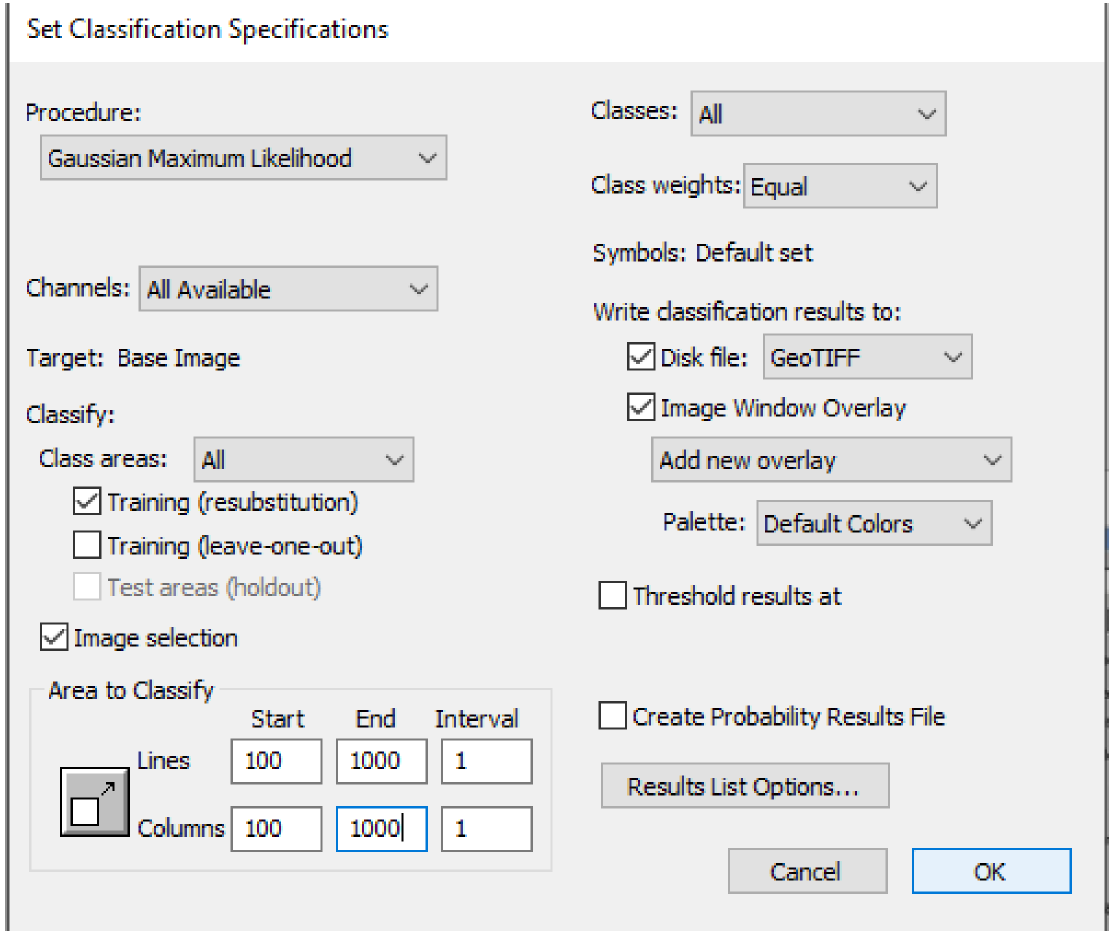




- **3. Processor – Classify** opens a window called Set Classification Specifications. In this window, you can choose both the qualifier type (Procedure menu) and the selected input parameters of the selected procedure. Leave the default values of the parameters, but check the Disk file box, which will allow you to save the classification results in a new file of the type e.g. GeoTIFF to disk. You can also check the Image Window Overlay option to directly display the classification result in the MultiSpec window. Confirm the Update project statistics window and save the output.

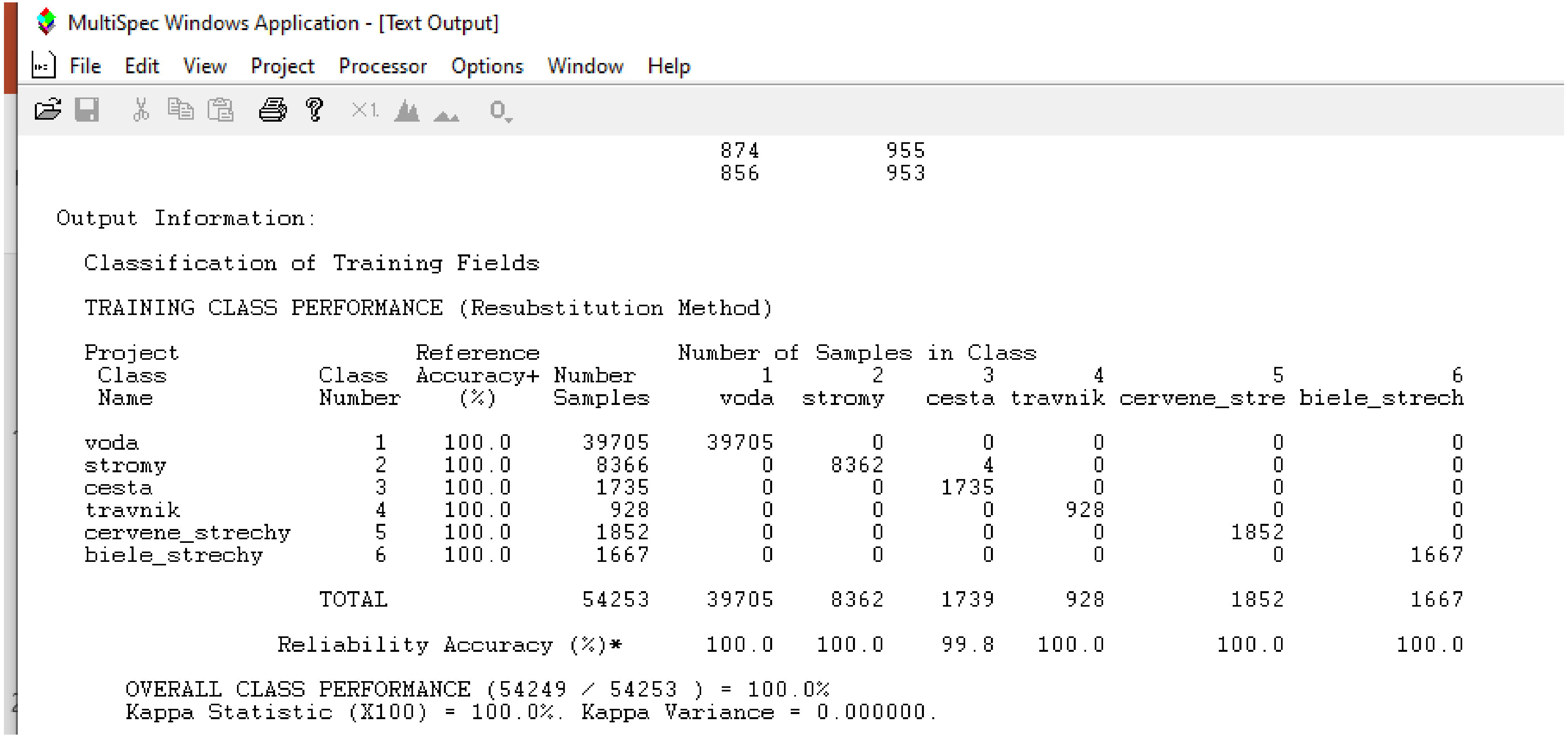
Classifiers that can be used for classification:

- *Maximum likelihood (maximum likelihood classifier - belongs to the most frequently used decision rules in controlled classification of satellite images and gives good results with suitable training areas*
- *Correlation (SAM) – classification of the so-called spectral angle, a decision rule originally used for hyperspectral image data...*



4. Evaluation of the result of supervised classification

-In addition to the file with classified data, the output of individual algorithms is also directed to the **text window** of the Multispec program. This window can be saved as a text file using the menu File - Save text output as...


MultiSpec Windows Application - [Text Output]

File Edit View Project Processor Options Window Help

874 955
856 953

Output Information:

Classification of Training Fields

TRAINING CLASS PERFORMANCE (Resubstitution Method)

Project Class Name	Class Number	Reference Accuracy+ (%)	Number Samples	Number of Samples in Class 1 voda	2 stromy	3 cesta	4 travnik	5 cervene_stre	6 biele_strech
voda	1	100.0	39705	39705	0	0	0	0	0
stromy	2	100.0	8366	0	8362	4	0	0	0
cesta	3	100.0	1735	0	0	1735	0	0	0
travnik	4	100.0	928	0	0	0	928	0	0
cervene_strechy	5	100.0	1852	0	0	0	0	1852	0
biele_strechy	6	100.0	1667	0	0	0	0	0	1667
	TOTAL		54253	39705	8362	1739	928	1852	1667
	Reliability Accuracy (%)*			100.0	100.0	99.8	100.0	100.0	100.0

OVERALL CLASS PERFORMANCE (54249 / 54253) = 100.0%
Kappa Statistic (X100) = 100.0%. Kappa Variance = 0.000000.

III

MultiSpec

PCA - Principal Component Analysis

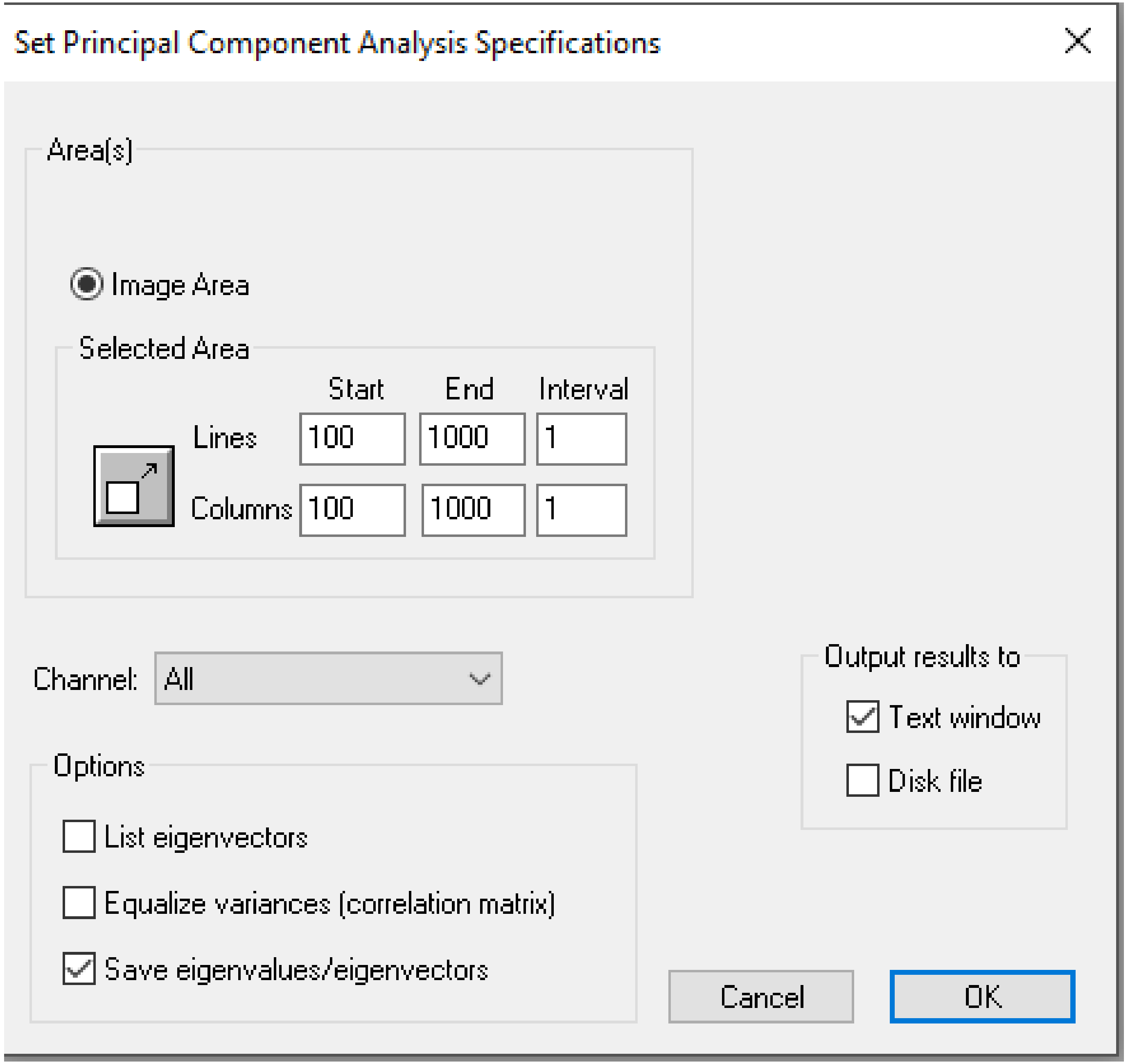
- Creating new variables/components that are a linear combination of the original variables without substantial loss of information

1.) Open image

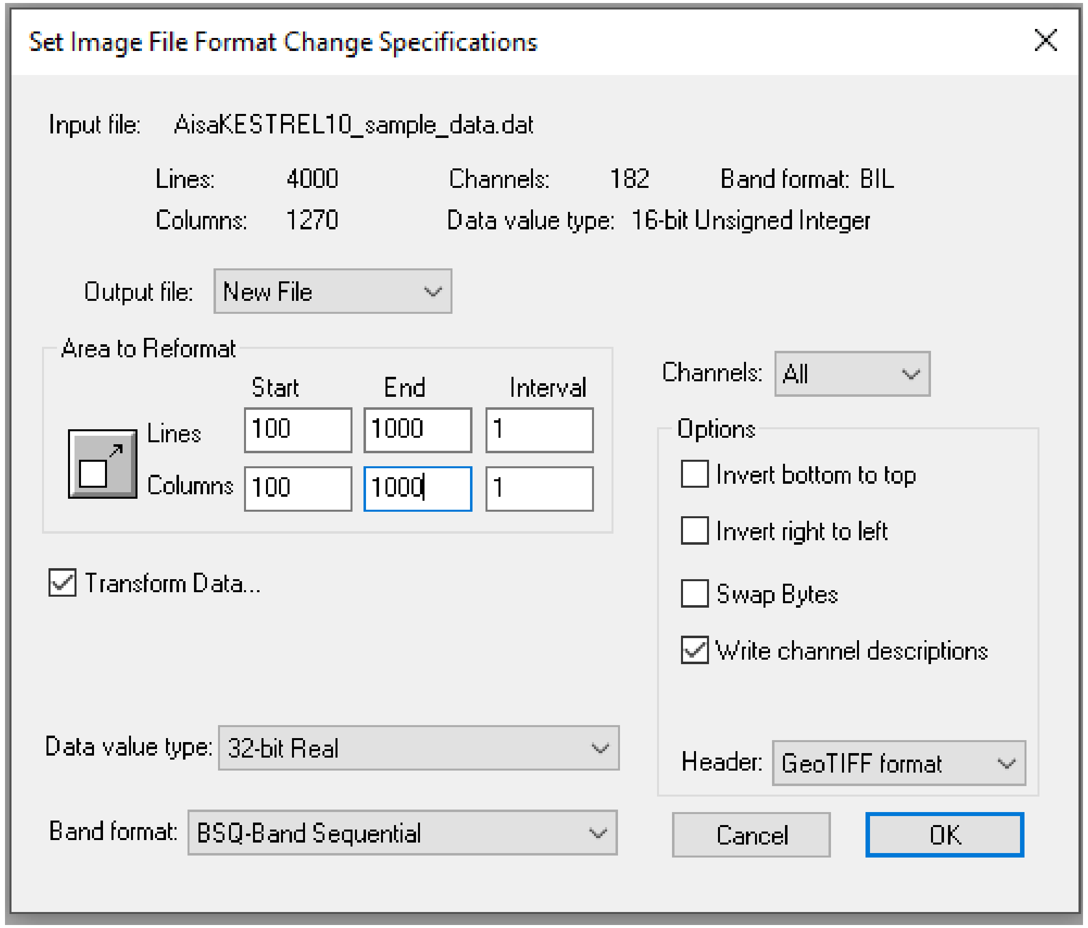
File - Open Image

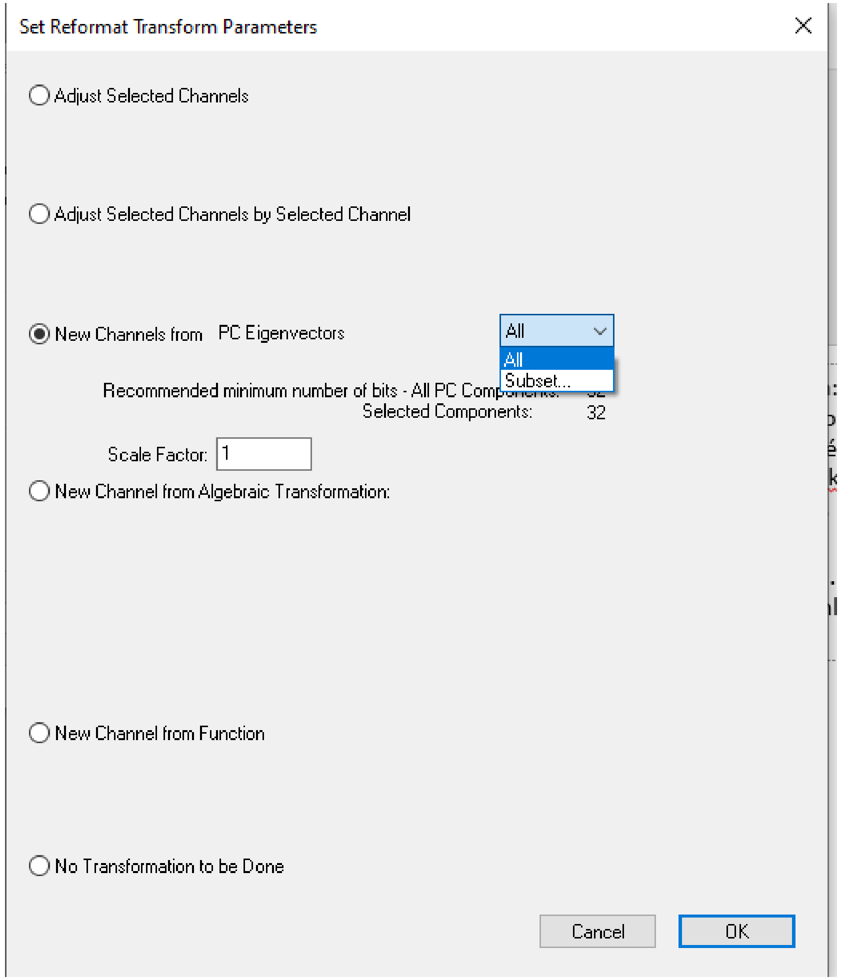
2. Transform the image using the method of principal components by selecting **Processor – Utilities – Principal Component Analysis**. In the window that opens, you can set parameters that define the range of input data. The analysis can include all or only some of the bands of the hyperspectral image (Subset), the entire range of rows and columns or only a part of them

3**. Save eigenvalues/eigenvectors** - that are used to calculate the so-called main components – mutually uncorrelated data transformed into a new space. Also check the option to save as text output (Note: do not check the option to save to Disk file!). The transformation matrix can also be saved to a file on disk by selecting File – Save Transformation Matrix. It is saved in the directory where the original data is located as a file with the same name as the original data with the ending *.TRA. The results of all calculations are also displayed in the text window of the program.

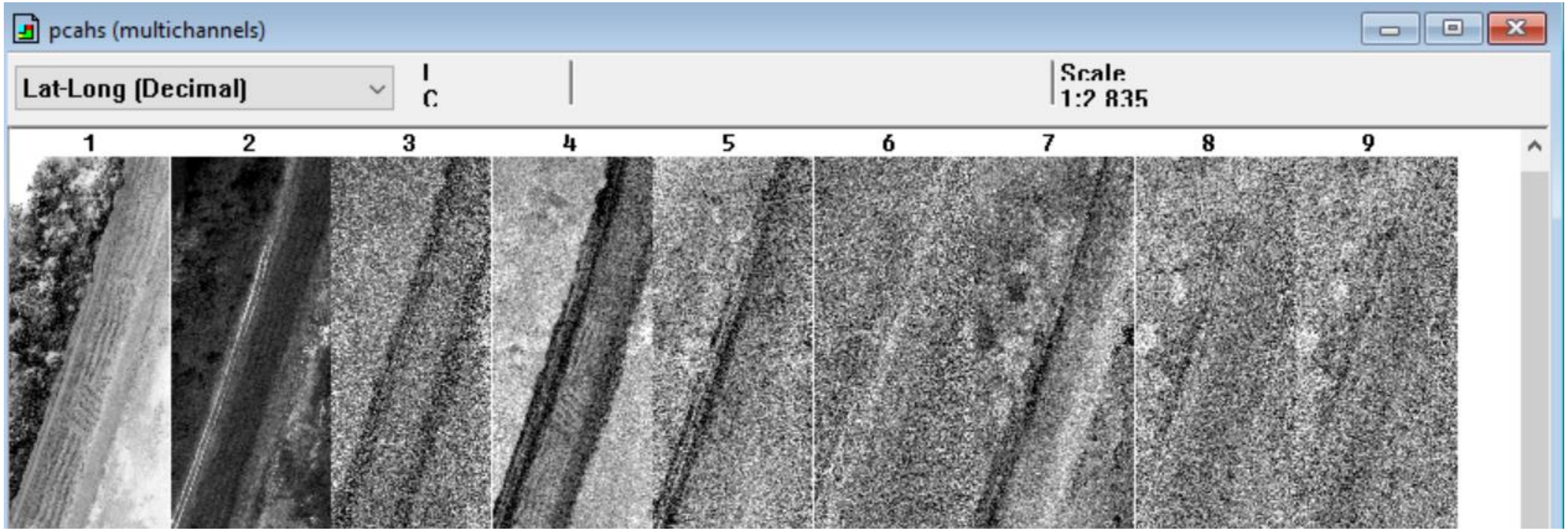


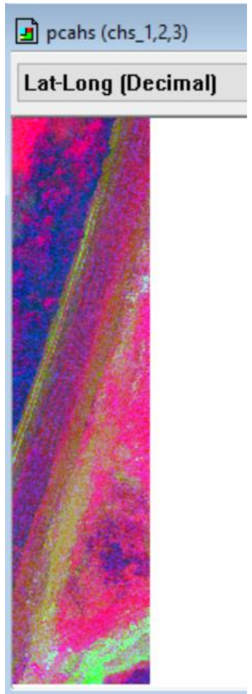
4. **Processor – Reformat – Change Image File Format**. In the window that appears, check Transform data and in the new window choose New Channels from PC Eigenvectors. You can select only a subset (if you want to use only certain/significant principal components that e.g. comprise more than 3% - you can find them in the text window) or all bands. Confirm the following two requests with the OK button. Subsequently, you are invited to save the image created by the analysis of the main components in a ***.LAN file**. Enter a file name and save it.





5. Next, you can view the transformed image. Choose **File - Open Image**. Select the resulting file of type ***.LAN**. In the Set Display Specifications for ... window, select **Side by Side Channels as the Display type**. This allows you to view the individual main components side by side in the form of grayscale images, as in the images below.





A sample of nine images transformed by the principal component analysis method from the AISA KESTREL bands. Notice the gradual loss of useful information, or noise increase in major components with higher numbers. PCA will therefore allow us to use instead of all bands after transformation for further work, such as to create a color composition, only a subset - the first e.g. three components that capture the largest part of the information, and we can neglect the remaining bands, as they include only a negligible part of the information. This will speed up e.g. subsequent creation of image classification.

CONCLUSION

- The aim of this practical was to demonstrate how quickly and (relatively) precisely we can classify HS data for e.g. estimation of land cover classes
- Fusion of HS and lidar data
- Spectral information, spatial (geometry) + surface structure (CHM)
- Today, we have even more sensitive and precise algorithms for HS data classification that generate even better results, like machine and deep learning, however, they require more time for processing/ and various input data

THANK YOU
FOR
YOUR ATTENTION

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