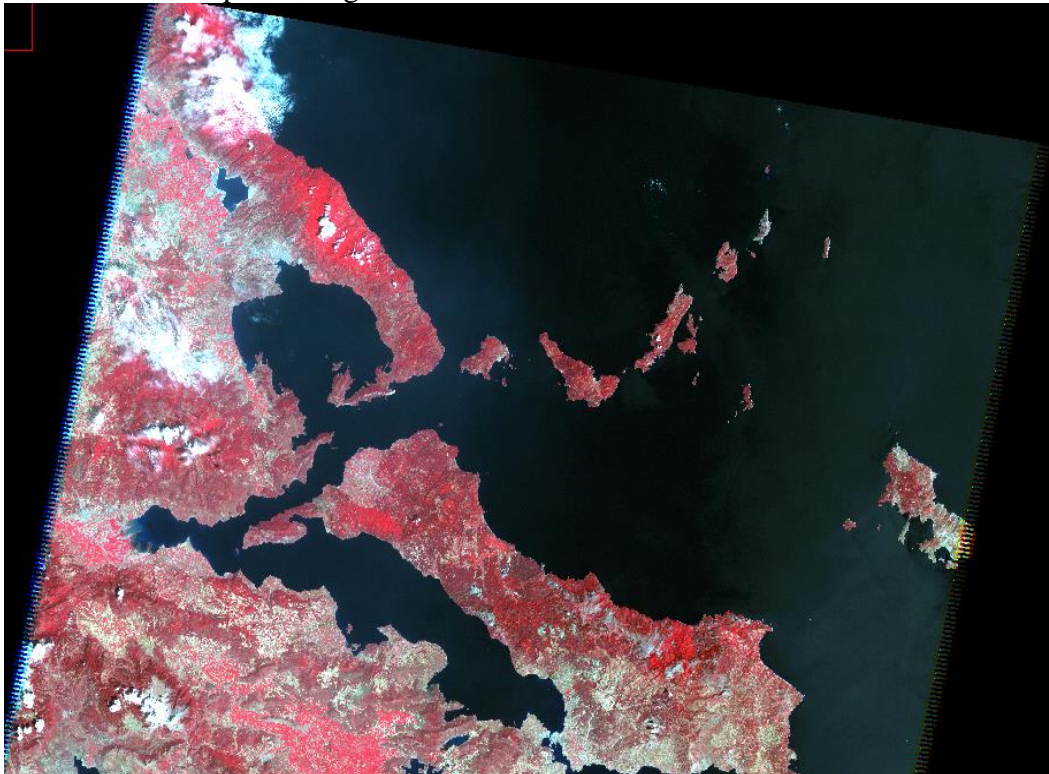


ENVI 5.0: TUTORIAL 3

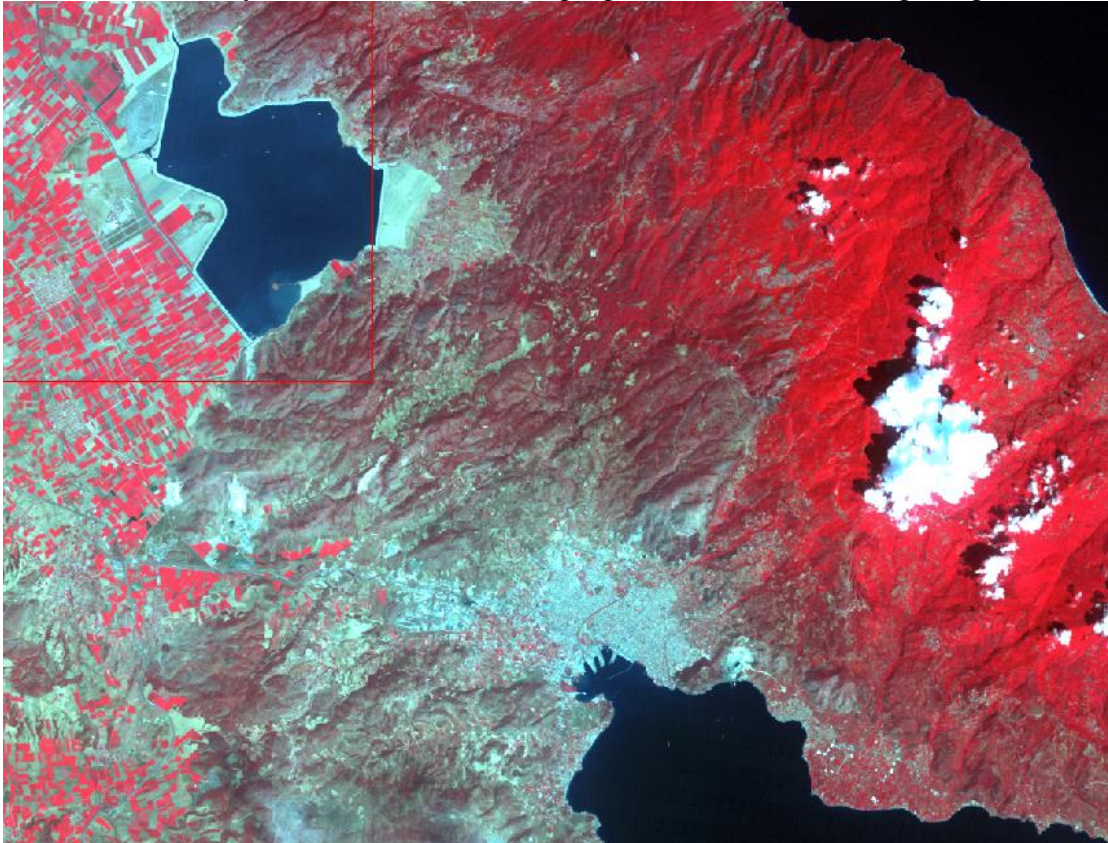
In this exercise, you can learn how to make unsupervised and supervised classification using ENVI 5.0. Generally, classification is the process of assigning class membership to a set of samples. In the case of remote sensing, the samples are the pixels of a specific image. Pixels can be classified on the basis of spectral similarity, using a variety of statistical techniques. Classes may be defined using ground reference data and/or previous knowledge of the site. This exercise leads you through a typical multispectral classification procedure using Landsat TM data for eastern Thessaly, central Greece. Results of both unsupervised and supervised classifications are examined and discussed.

1. Locate the TM image that corresponds to 15/8/2011. Select the file and click Open Image File on the ENVI main menu. You can open the image directly as an external file (GeoTIFF with metadata).
2. You may only use the bands 1,2,3,4,5 and 7. Calibrate the images. Go to “Basic Tools”→ Pre-processing→Calibration utilities→Landsat Calibration.



3. Save the output and open as an RGB color (4,3,2 channels). Resize the image. You can avoid large files using only the desired geographical regions. From the Basic Tools menu click resize data (spatial). This menu also allows you to select specific spectral bands for display and processing.
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4. You have the choice of loading either a gray scale or an RGB color image. Select the RGB Color radio button in the Available Bands List, and then click on bands 4,3, and 2 sequentially with the left mouse button. The bands you have chosen are now displayed in the appropriate fields in the center of the dialog.
5. Use the displayed color image as a guide to classification.
6. Review Image Colors → there are areas that have similar spectral characteristics. Bright red areas on the image have high infrared reflectance and low reflectance in the red and green, which is characteristic of healthy vegetation, especially that under cultivation. Slightly darker red areas typically represent native vegetation. Water surfaces (Pagasitikos Golf and Lake Karla) are also readily apparent. Urbanization and clouds are also easy to detect. The following figure shows the resulting image file.



Unsupervised classification

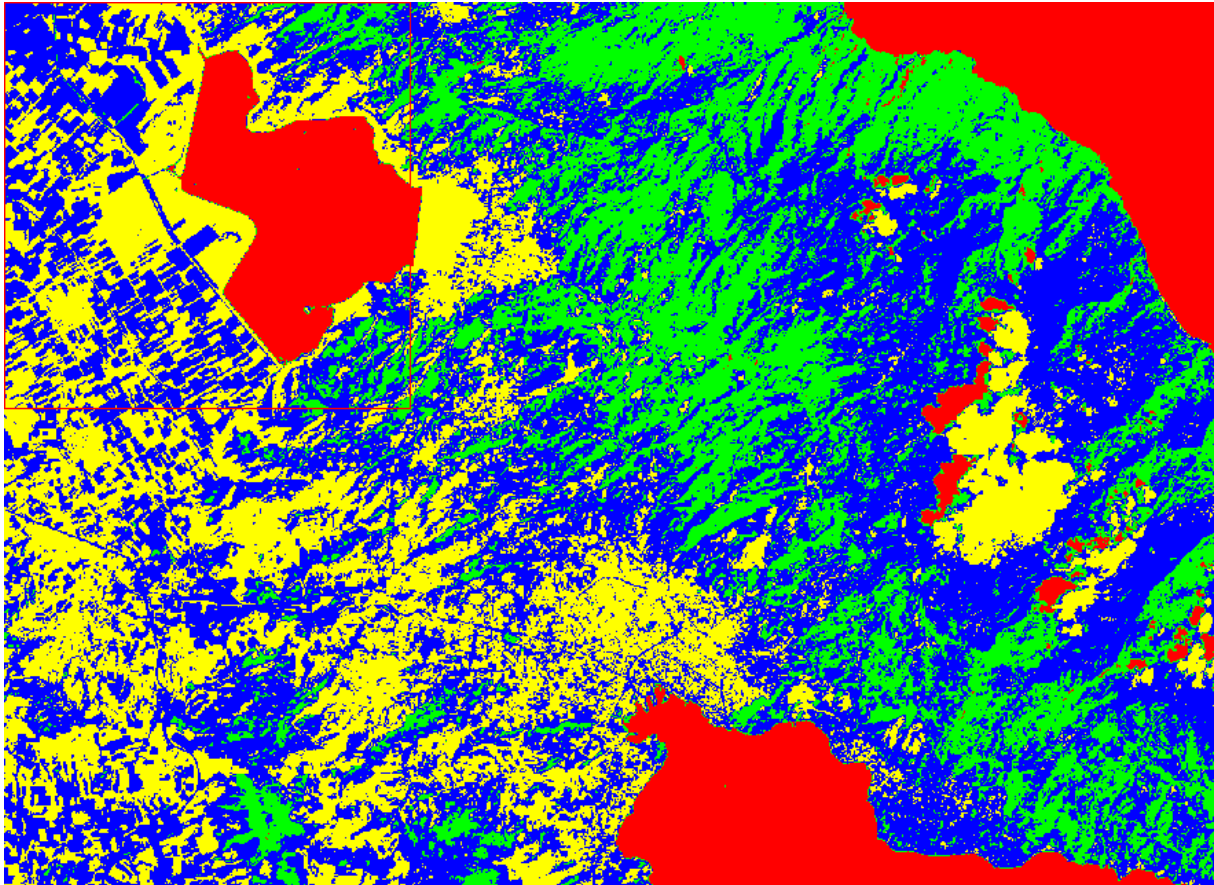
Start exploring ENVI's unsupervised classification capabilities using the ENVI main menu, by choosing Classification → Unsupervised → K-Means or IsoData.

K-Means

Theory: Unsupervised classifications use statistical techniques to group **n-dimensional data** into their **natural spectral classes**. The K-Means unsupervised classifier uses a cluster analysis approach which requires the analyst to select the number of clusters to be located in the data. The classifier arbitrarily locates this number of cluster centers, and then iteratively repositions them until optimal spectral separability is achieved.

1. Select Classification → Unsupervised → K-Means, and use all the default values.

2. Select the previous saved image of your own and click OK.
3. Select the number of the desired classes and click OK.
4. Load the new image file just clicking on the Gray Scale Radio Button → Load Band
Keep the initial image on Available Band Lists Window, open it and Link it with the new classification image file. Select Tools → Link → Link Displays and click OK in the dialog in order to link the images.
5. Compare the classification result with the initial color composite image.
6. Try to identify the land cover associated with each class
7. Experiment with different numbers of classes

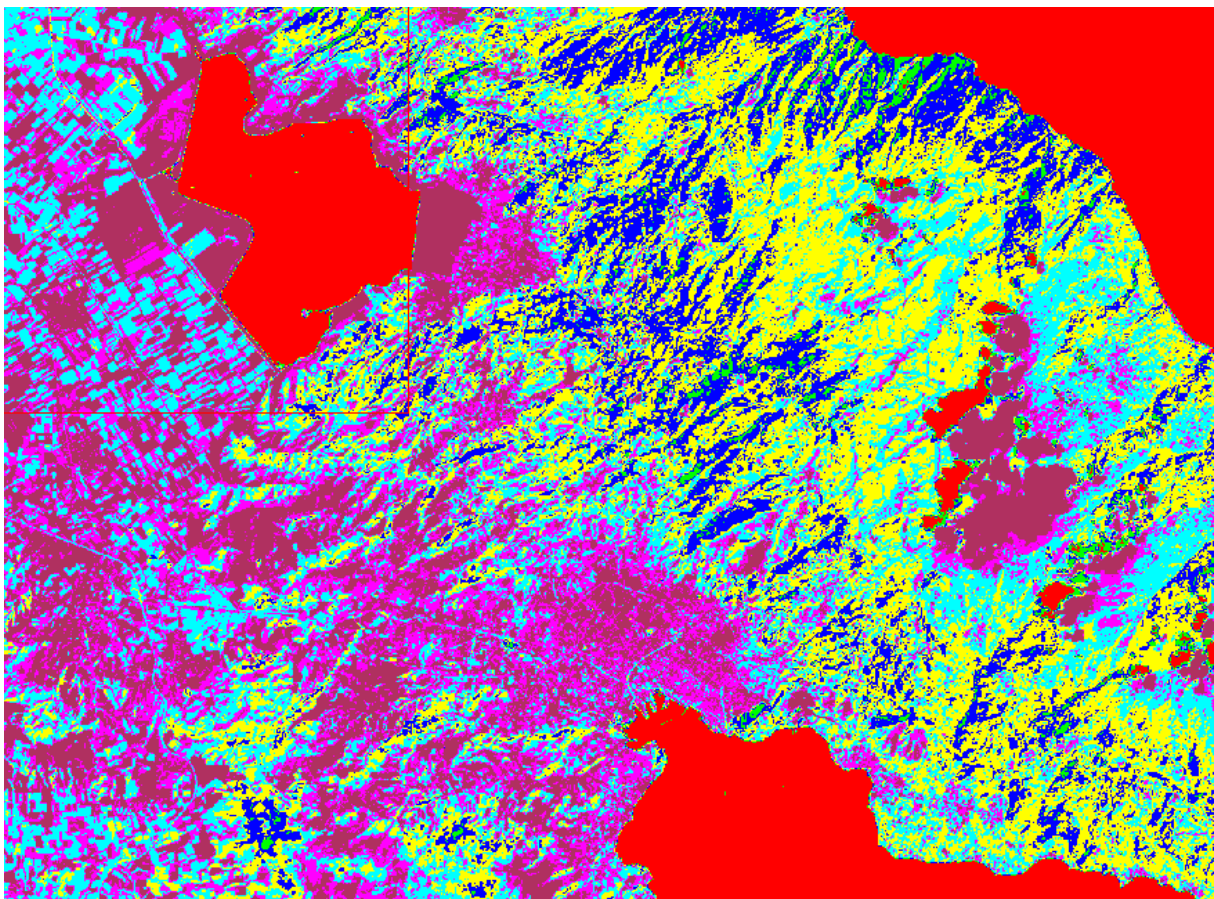


IsoData

Theory: IsoData unsupervised classification calculates class means evenly distributed in the data space and then iteratively clusters the remaining pixels using minimum distance techniques. Each iteration recalculates means and reclassifies pixels with respect to the new means. This process continues until the number of pixels in each class changes by less than the selected pixel change threshold or when the maximum number of iterations is reached.

1. Select Classification → Unsupervised → IsoData, and use all the default values.
2. Select the previous saved image of your own and click OK.
3. Select the range number of the desired classes and click OK.
4. Try to identify the land cover associated with each class and write this down.

5. Load the new image file just by clicking on the Gray Scale Radio Button → Load Band. Keep the initial image on Available Band Lists Window, open it and Link it with the new classification image file. Select Tools → Link → Link Displays and click OK in the dialog to link the images. Do exactly the same with the previous K-Means classification image file.
6. Compare the results of the two methods. It is very possible that the two classifiers may have assigned different colors to similar spectral classes. Try to find the reason for this difference.
7. Experiment with different numbers of classes, change thresholds, standard deviations, maximum distance error, and class pixel characteristic values to determine their effect on the classification.
8. You may close your K-Means and IsoData classification images.



Supervised classification

At the supervised classifications the user selects manually training areas in order to define each class. After the definition of each class, every pixel is then compared to the training data and assigned to the most appropriate class. There are many different supervised classification methods including Parallelepiped, Minimum Distance, Mahalanobis Distance, Maximum Likelihood, Spectral Angle Mapper, Binary Encoding, and Neural Nets.

In order to perform your own classifications, from the ENVI main menu select Classification → Supervised → [method], where [method] is one of the supervised classification methods

found in the pull-down menu (Parallelepiped, Minimum Distance, Mahalanobis Distance, Maximum Likelihood, Spectral Angle Mapper, Binary Encoding, or Neural Net).

For the selection of training areas Regions of Interests (ROIs) can be used. You can either use predefined ROIs, or create your own.

Restore or create ROIs

If there previous saved ROIs for the same region under consideration, and if the images are appropriately georeferenced, you can restore the ROIs simply by opening the ROI Tool dialog by choosing Overlay → Region of Interest in the display image window. In the ROI Tool dialog, choose File → Restore ROIs.

You can also create your own new ROIs. Select Overlay → Region of Interest from the Main Image window menu bar. The ROI Tool dialog for the display group appears. In the Display Image window draw a polygon representing the new region of interest. To do this, click the left mouse button in order to establish the first point of the ROI polygon. Select further border points in sequence by clicking the left button again, and close the polygon by clicking the right mouse button. The middle mouse button deletes the most recent point, or (if you have closed the polygon) the entire polygon. Fix the polygon by clicking the right mouse button later on. When you have finished creating a ROI, its definition is shown in the table of the ROI Tool dialog. The definition includes the name, region color, number of pixels enclosed, as well as other ROI properties.

Supervised Multispectral Classification Methodologies

Parallelepiped

A simple decision rule is used here in order to classify multispectral data. The decision boundaries form an n-dimensional parallelepiped in the image data space. The dimensions of the parallelepiped are defined based upon a standard deviation threshold from the mean of each selected class. Pixels are assigned to a class when they occur within that class's parallelepiped. In the case that they are outside of the parallelepipeds, they are left unclassified.

In order to create a parallelepiped classification, go to the Main ENVI menu and select Classification → Supervised → Parallelepiped. You can run the classification using the default parameters and the previous created ROIs. Save your results in the folder of your choice. Compare this classification with the color composite image. Do you see any pixels that are obviously misclassified?

Minimum distance

This type of classification uses the mean spectral values of each ROI and calculates the Euclidean distance from each unknown pixel to the centroid for each class. In this way, all pixels are classified to the closest ROI class unless the user specifies standard deviation or distance thresholds, in which case some pixels may be unclassified in the case that they do not meet the selected criteria.

In order to create a minimum distance classification, go to the Main ENVI menu and select Classification → Supervised → Minimum Distance. You can run the classification using the default parameters and the previous created ROIs. Save your results in the folder of your choice. Compare this classification with the color composite image. Do you see any pixels that are obviously misclassified? Can you observe any significant differences?

Maximum Likelihood

Maximum likelihood classification assumes that the reflectance values for each class in each band are normally distributed and calculates the probability that a given pixel belongs to each class. Unless a probability threshold is selected, all pixels are classified. Each pixel is assigned to the class for which it has the highest probability of membership (i.e., the maximum likelihood).

In order to create a maximum likelihood classification, go to the Main ENVI menu and select Classification → Supervised → Maximum Likelihood). You can run the classification using the default parameters and the previous created ROIs. Save your results in the folder of your choice. Compare this classification with the color composite image. Do you see any significant differences?

Mahalanobis distance

The Mahalanobis Distance classification is based on a direction sensitive distance classifier that uses covariance statistics in addition to class means and standard deviations. It is very similar to the Maximum Likelihood classification but assumes all class covariances are equal and therefore is a faster method. All pixels are classified to the closest ROI class unless the user specifies a distance threshold, in which case some pixels may be unclassified if they do not meet the threshold.

In order to create a Mahalanobis distance classification, go to the Main ENVI menu and select Classification → Supervised → Mahalanobis distance classification. You can run the classification using the default parameters and the previous created ROIs. Save your results in the folder of your choice. Compare this classification with the color composite image. Do you see any pixels that are obviously misclassified? Can you observe any significant differences between the parallelepiped and minimum distance results?

Post-classification

Combine Classes

The Combine Classes function provides an alternative method for classification generalization. Similar classes can be combined into a single more generalized class.

Perform your own combinations as described below:

1. Select Classification → Post Classification → Combine Classes.
2. Select the previous classification and click OK.
3. Choose the first (as the input class) to combine with Unclassified (as the output class), and click on Add Combination, and then OK in the Combine Classes Parameters dialog. Choose —Yes in response to the question —Remove Empty Classes? Output as a new image and click OK.
4. Compare the combined class image to the classified images.

Edit Class Colors

When a classification image is displayed, you can change the color associated with a specific class by editing the class colors:

1. Select Tools → Color Mapping → Class Color Mapping in the Main Image Display window of the classification image.
2. Click on one of the class names in the Class Color Mapping dialog and change the color by dragging the appropriate color sliders or entering the desired data values. You may choose from a pulldown menu of color options by clicking on the — Color menu. Changes are applied to the classified image immediately. To make the changes permanent, you can select Options → Save Changes in the dialog. You can also edit the names assigned to classes in this dialog.

Classes to Vector Layers

Execute the function and convert one of the classification images to vector layers which you can use in a GIS.

1. Select Classification → Post Classification → Classification to Vector and choose the Selected classification file within the Raster to Vector Input Band dialog.
2. In the Raster to Vector Parameters, you can choose which classes you wish to convert to vectors and also whether you would like all classes to be in a single vector file or for a separate vector file to be created for each class.
3. It is possible that the described conversion to vectors would be very time consuming, so be patient.

Classification Keys Using Annotation

ENVI provides annotation tools to put classification keys on images and in map layouts. The classification keys are automatically generated.

1. Choose Overlay → Annotation from the Main Image window menu bar for one of the classified images.
2. Select Object → Map Key to add a legend to the image. You can edit the key characteristics by clicking on the Edit Map Key Items button in the Annotation: Map Key dialog and changing the desired characteristics. You should shorten the class names that will be displayed.
3. Click in the image display to place the key. In the Annotation dialog, turn on the background and choose a background color that will allow your legend to be legible.
4. Click in the display with the right mouse button to finalize the position of the key. For more information about image annotation, please see previous exercises.