

## Practical – Introduction to ENVI

### Aims and Objectives

The aim of this practical is to introduce you to ENVI and the basics of digital image display.


### Core Tasks for this practical

1. Viewing image data
2. Zooming in and out of image data
3. Displaying colour composites
4. Image Enquiry

At the end of this practical you should be familiar with some of the basic workings of ENVI and with the nature and form of remote sensing image data

## Data for this Practical

### Images used in this practical

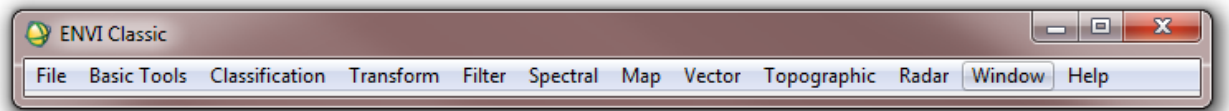
File name	Charleston_tm_1994_02_03	Quick look (RGB = 4,3,2)
Location	Charleston USA, SC	
Sensor	Landsat TM	
Spatial	30 m x 30 m in optical bands	
Temporal	Obtained Feb. 3 1994	
Spectral	Band 1 = Blue (0.45 - 0.52 µm) Band 2 = Green (0.52 - 0.60 µm) Band 3 = Red (0.63 - 0.69 µm) Band 4 = NIR (0.76 - 0.90 µm) Band 5 = SWIR (1.55 - 1.75 µm) Band 6 = TIR (10.4 - 12.5 µm) Band 7 = SWIR (2.08 - 2.35 µm)	

Unzip the imagery into a new folder with a name of your choosing before working through this practical.

## Starting ENVI

1. Start up your copy as follows ENVI 5.2> Tools > ENVI Classic (64 bit)

The main menu bar will appear at the top of your screen

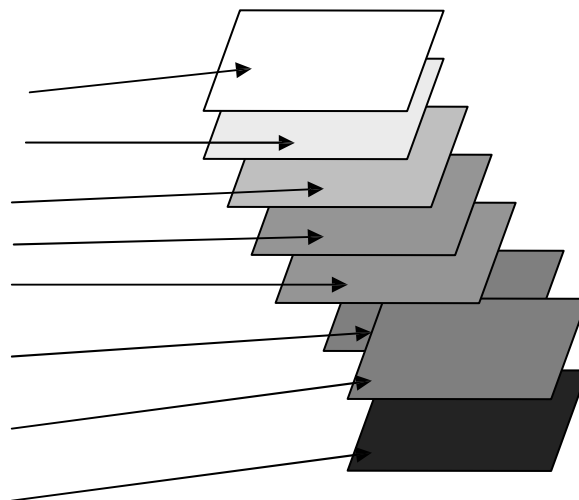


## ENVI main menu bar

### Introducing the Data

The image file that you will be working with is a subset of a Landsat Thematic Mapper (TM) image of Charleston USA. The file contains the 7 Landsat TM bands - it is easier to visualise the structure of the image files if you think of each file being composed of a stack of separate images (figure 2).

- |   |       |                           |
|---|-------|---------------------------|
| 1 | Blue  | 0.45 - 0.52 $\mu\text{m}$ |
| 2 | Green | 0.52 - 0.60 $\mu\text{m}$ |
| 3 | Red   | 0.63 - 0.69 $\mu\text{m}$ |
| 4 | NIR   | 0.76 - 0.90 $\mu\text{m}$ |
| 5 | MIR   | 1.55 - 1.75 $\mu\text{m}$ |
| 6 | TIR   | 10.4 - 12.5 $\mu\text{m}$ |
| 7 | MIR   | 2.08 - 2.35 $\mu\text{m}$ |



## TM bands 1-7

### INFORMATION BOX

Unless image data is converted to reflectance, pixel brightness values in an image are represented by digital numbers which range from 0 to one less than a selected power of 2 (e.g., 0 to 255). **The maximum number of brightness levels available depends on the number of bits used in representing the energy recorded by a sensor.** Thus, if a sensor used 8 bits to record the data, there would be  $2^8=256$  digital values available, ranging from 0 to 255. However, if only 4 bits were used, then only  $2^4=16$  values ranging from 0 to 15 would be available. If 2 bits were used then there would be even fewer digital values available,  $2^2 = 4$  values! A 1-bit image would have only 2 values!

Image data are generally displayed in a range of grey tones, with black representing a digital number of 0 and white representing the maximum value (for example, 255 in 8-bit data). By **comparing a 2-bit image with an 8-bit image**, we can see that there is a large difference in the level of detail and contrast discernible depending on their radiometric resolutions.



Figure 3a: 6-bit image – 64 values



Figure 3b: 4-bit image – 16 values



Figure 3c: 2-bit image – 4 values



Figure 3d: 1-bit image – 2 values

### **TASK1: Image Display - Loading a Grayscale Image**

*These notes have been taken from ENVI Tutorials*

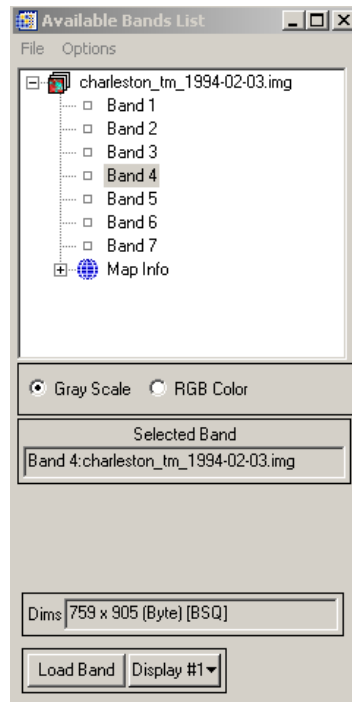
#### **1. Select **File/ Open Image File.****

An Enter Data filenames selection dialog appears.

1. Navigate to your chosen folder just as you would in any other application, and select the file ***Charleston\_tm\_1994-02-03*** from the list and click **Open**

The Available Bands List dialog appears on your screen. This list allows you to select spectral bands for display and processing.

**Note:** At this point you have the choice of loading either a grayscale or an RGB colour image



2. Click on the **Gray Scale** toggle button
3. Select **Band 4 (NIR)** in the dialog by clicking on the band name in the Available Bands List.

The band you have chosen is displayed in the field marked **Selected Band**

4. Chose **Load Band** in the Available Bands List to load the image into a new display.

Band 4 will be loaded as a grayscale image.

The display now shows a NIR (Near Infrared) image of Charleston. Note the grey contrast in the image. The grey palette ranges from black (colour '0') to white (colour '255').

## **TASK 2: Zooming and Roaming around an Image in ENVI**

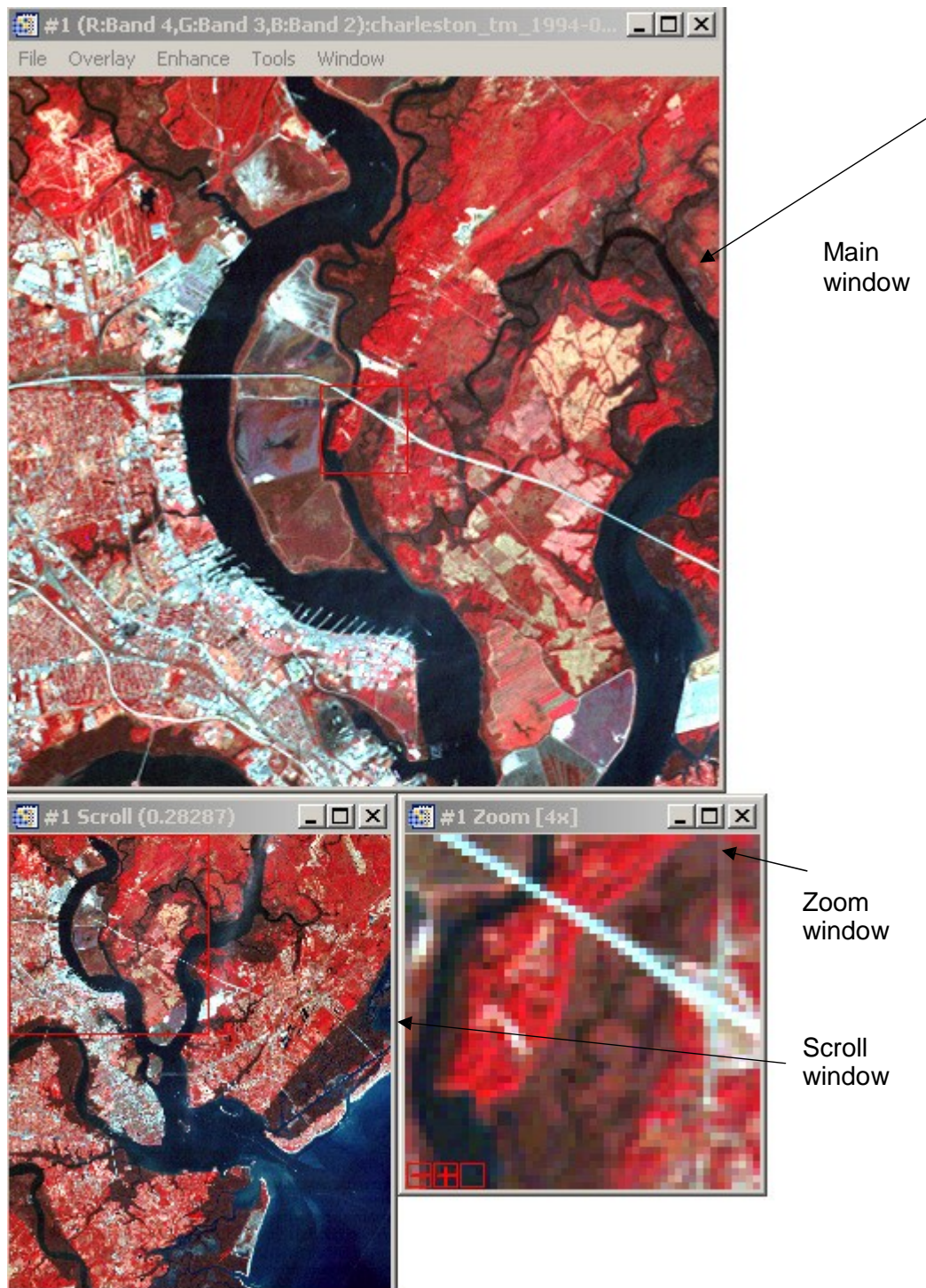
*These notes have been taken from the ENVI Tour Guide*

**Prepare: Display band 4 of the Charleston image in the main window (if not already displayed)**

### **A. Roaming around an Image**

When the image loads, an ENVI image display appears on your screen. The display group consists of 3 windows (figure 4):

- A) A Main Image window
- B) A Scroll window
- C) A Zoom window.



### **The Main, scroll and zoom windows in ENVI**

The windows are intimately linked; changes to one window are mirrored in the others. All windows can be resized by grabbing and dragging a window corner with the left mouse button.



### **The Scroll Window**

The Scroll window displays the entire image at reduced resolution (sub-sampled). The highlighted scroll control box (red by default) indicates the area shown at full resolution in the Main Image window.

1. Move the Scroll window indicator box around the scroll image to display different portions of the image in the Main Image display at full resolution.

### **The Main Image Window (Viewer)**

The Main Image window shows a portion of the image at full resolution.

### **The Zoom Window**

The Zoom window shows a portion of the image magnified the number of times indicated by the number shown in parentheses in the Title Bar of the window.

## **B. Zooming**

1. Click and drag the Zoom box (the square red box) around in the Main Image display using the left mouse button.
2. When the Zoom box is over an area of interest, release the mouse button

You'll see the image in greater detail in the Zoom window.

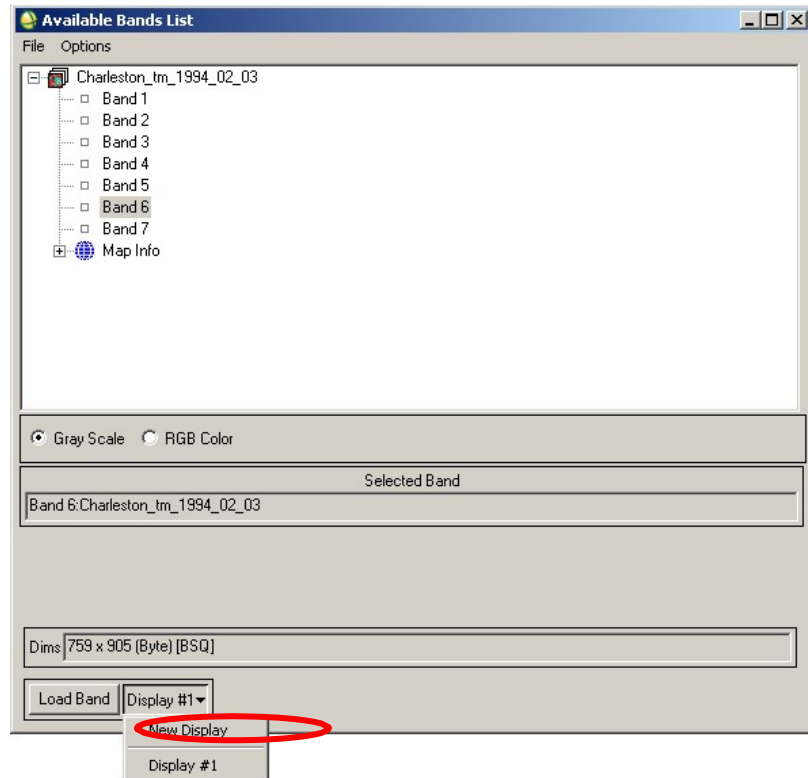
3. In the Zoom window, click the left mouse button on the – (minus) graphic in the lower left corner

Zooms out by a factor of 1.

4. In the Zoom window, click the left mouse button on the + (plus) graphic in the lower left corner

Zooms in by a factor of 1

5. Position the Zoom box at various locations in the Main Image window and examine the data.
6. Now **load band 6** into a new display by clicking on band 6, New display and then Load band (see figure below).



7. You can link displays together so that the same location is simultaneously viewed in each display. Link the displays for Band 4 and Band 6. Select **Tools/Link/Link Display/OK** from any of the image menus
8. Open the remaining 5 bands in new displays and link them using the same steps outlined above.

**Question1:**

***You will see a specific difference between band 6 and all the other bands. Explain why band 6 looks different***

**Question2:**

***Which of the available seven bands provides the most information about the shallow sea bed and why?***

### TASK 3: Displaying Colour Composites

In this section we will learn how to display colour composite images. Colour composite images let us view the reflectance information from *three* separate bands in a single image

#### A. Displaying a True Colour Image

1. Before we begin close all open files
2. Select **File / Open Image File** on the ENVI main menu.
3. Navigate to your home directory and open the Charleston image.
4. The Available Bands List dialog appears on your screen.
5. Select the **RGB Colour** radio button in the Available Bands List
6. Click on bands 3, 2, and 1 sequentially with the left mouse button.

The bands you have chosen are displayed in the appropriate RGB fields in the centre of the dialog.

7. Click on the **Load RGB** button to load the image into a new display.

In this image, we have used TM bands 3, 2 and 1 (red, green and blue) and we have created a *natural* colour composite in which blue brightness information is displayed with blue light phosphors in the computer display, green brightness information with green light phosphors and red brightness information with red light phosphors. Our interpretation of the spectral response patterns underlying the particular colours we see in the composite is therefore quite intuitive. However, any combination of bands may be used and assigned to the 3 computer light phosphors - the choice often depends on the particular application and the information content of the bands.

**NOTE:** If you are unsure about the physics of light, please take the time to read info box 1.

#### INFORMATION BOX: The physics of visible light

When all the wavelengths of visible light are mixed in equal proportions, white light is created. White is not a colour but rather the combination of all the colours of the visible light spectrum. Likewise black is not actually a colour, it is black is merely the absence of the wavelengths of the visible light spectrum.

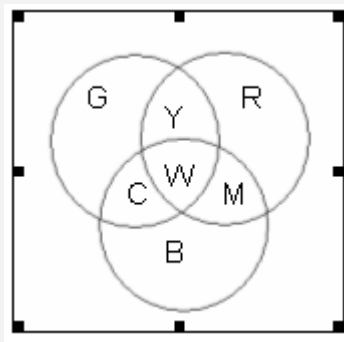
The complexities of colour perception can be reduced if we think in terms of primary colours of light. When we speak of white light, we are referring to ROYGBIV (red, orange, yellow, green, blue, indigo, violet) - the presence of the entire spectrum of visible light. But combining the range of frequencies in the visible light spectrum is not the only means of producing white light. Combining only **three** distinct frequencies of light can also produce white light, provided that they are widely



separated on the visible light spectrum. Any three colours (or frequencies) of light which produce white light when combined with the correct intensity are called **primary colours of light**. There are a variety of sets of primary colours but the most common set of primary colours is **red, green and blue**. When red, green and blue light are mixed or added together with the proper intensity, white (W) light is obtained. This is often represented by the equation below:

$$R + G + B = W$$

In fact, the mixing together (or addition) of these three primary colours of light with varying degrees of intensity can produce a wide range of other colours. The diagram below represents 3 coloured spotlights: red, green and blue. Where these spotlights cross produces a new colour. For example,  $R + G = \text{yellow (Y)}$ ,  $G + B = \text{cyan (C)}$  and  $\text{blue} + \text{red} = \text{magenta (M)}$



**Television sets and computer monitors use red, green and blue phosphors** because the addition of these three primary colours of light with varying degrees of intensity will result in the other colours found in the visible light spectrum. Since computer monitors have only 3 display phosphors - green, blue and red, it is impossible to display more than 3 image bands at once. We can use either a single band or combinations of three bands to display imagery. The colour of features in the image display (e.g. water, vegetation, urban areas) will depend which image band has been assigned to which display colour and on the amount of radiation reflected in that band.

### **B. Displaying a Standard False Colour Composite**

1. Create a new composite image using the same procedure as before, except this time in the available bands list assign band 4 to Red (R) band 3 to Green (G) and band 2 to Blue (B). This is what is known as a standard false colour composite.

#### **Question3:**

**(a) What colour does vegetation appear in this image and why?**

***(b) Is it possible to create a true colour composite of SPOT HRV data? Explain your answer***

*(Note: you will have to do some additional reading to answer part b)*

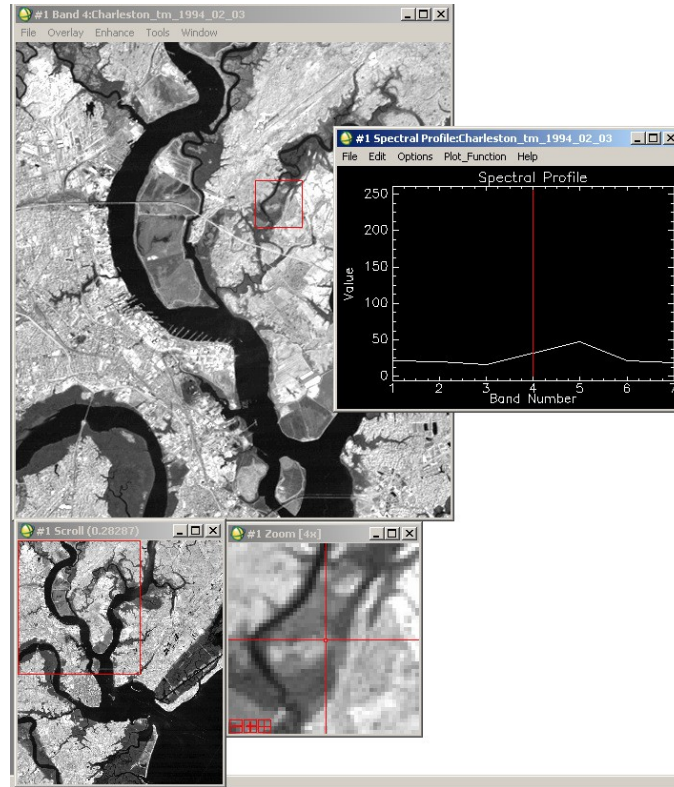
#### **TASK 4: Image Enquiry**

##### **Displaying image profiles**

ENVI allows us to extract the spectral profile (or spectral signature) of each pixel in the image. This information can be used to identify different surface types (e.g. vegetation, urban, water etc.) or to help us assess the status of the land surface (e.g. wet or dry, healthy or stressed etc.). ENVI calls the spectral profile of a pixel the *z profile (spectrum)*.

To display the spectral profile for a given pixel:

1. In the display window select **Tools/Profiles/Z profile (Spectrum)**.
2. A spectral profile dialogue box will appear. The z profile displays data values associated with a single pixel (under the zoom window cross hair), that is, for a particular point the reflectance response of each band in the image is plotted (not just the bands displayed on the screen).

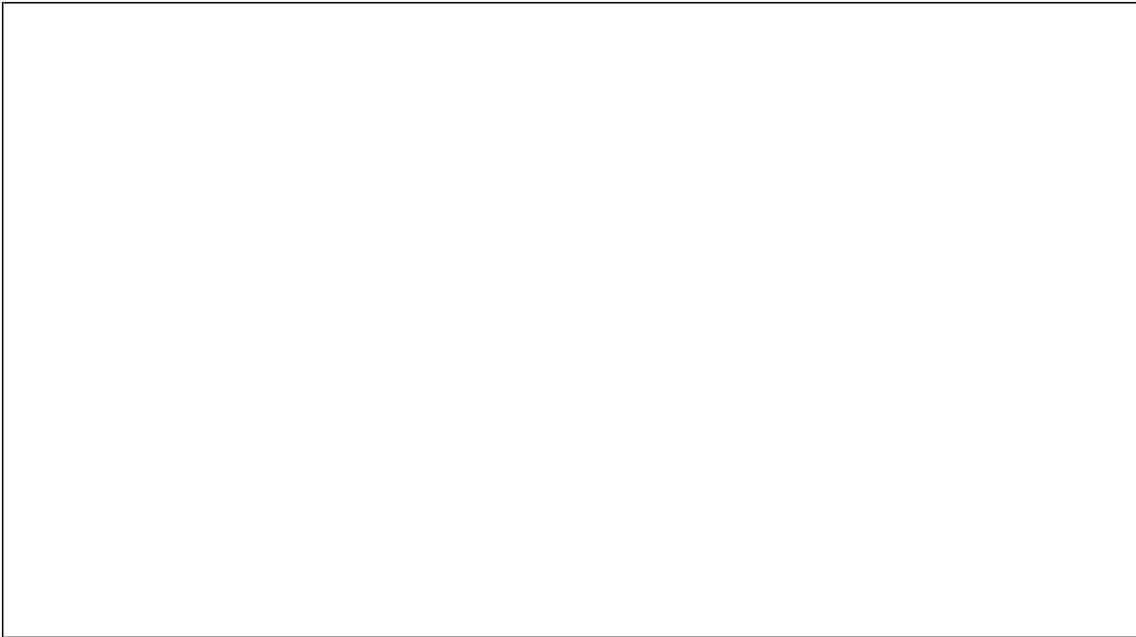


3. To extract the exact values for each band, click on the spectral profile above each band number. Two numbers will appear in the bottom left hand side of the screen which equate to the band number and data value e.g. 5, 50 would mean that the data value in band 5 is 50.
4. We will now use this technique to extract the spectral profiles of a number of land cover types. Collect data values for bands 1–5 and 7 for **5** to **6** representative pixels in each of the following cover types: a. Urban b. Water c. Upland vegetation (i.e. dry) and answer the following questions.

Note: You may want to display the image as a true or false colour composite to locate the correct land cover types.

***Question4:***

***Using the values noted from above, draw the spectral profile of Urban areas, Water and Upland vegetation in the space below and remember to label both axes. Think about how you should display the variation in values within each band.***



The graphs you have drawn are basic *spectral response patterns*. You should recall from the lectures that different cover types reflect different amounts of energy in different wavelengths.

**Question5:**

***Explain how and why the spectral response patterns drawn in question 4 differ within and between each of the land covers.***

