GEOM 3002 Lab 5

A. Field spectroscopy and spectral reflectance

B. Image display, processing and analysis in PCI Geomatica

Due October 30, 31 at the beginning of your lab session. Submit the lab to through cuLearn.
Submit all your answers in a Word document that lists the questions by Part and question number.
Example:
Part A.
1.
2.
Part B.
1a.
b.
2a. etc.

Note: This lab ramps up the intensity of learning and deliverables. With the foundation you have at this point in the course, you should not have any problems but for this and the subsequent labs, start early and keep up a sustained effort. Do not leave them until near their deadlines.

This lab is designed to be an introduction to basic reflectance theory and measurement and to digital multispectral satellite imagery, display, and analysis. Refer to the slides of Lecture 5 (reflectance), Lecture 6 (digital images and processing) and parts of Lecture 7 (sensors - Landsat) and the readings listed for each lecture for more details on these topics.

There are two sections to this lab; Part 1 is comprised of hands-on reflectance measurement using a spectrometer and questions based on the data collected. Part 2, is on image display and processing and requires the use of PCI Geomatica found on the computers in Loeb A237 and A200.

Note: we use PCI Geomatica software because it is one of the best image processing and analysis software systems in the world; it has about 1000 algorithms for many types of applications. It is also Canadian, and almost all Canadian organizations doing remote sensing image processing and analysis use it. At http://www.pcigeomatics.com under Resources > More Resources > Downloads, you can download:

1. PCI FreeView - like Focus, the software we will use in this and the next lab but with limited functionality – it only does some of the things required in this lab,
2. A 30-day trial version of the full Geomatica 2016 software suite.

Students can also buy a 1-year licence of the full Geomatica Educational Suite and SAR Polarimetric Software for $150 at http://www.studica.com/pci-geomatics-geomatica-for-students.html

If you are interested in other remote sensing software, ENVI and IDRISI have low cost student licenses and IDRISI is in the Geomatics lab (Loeb A200, A237). ArcGIS has improved its functionality in recent years and is a good alternative for some applications.

The value of each question is given in brackets. 42 total marks / 4.2 = 10% of final course grade.

<u>A. Field Spectroscopy</u> (15 marks)

Spectral reflectance is the basic surface property associated with image brightness in a given spectral band in the visible, near infrared and mid infrared. Remotely sensed images are often converted from pixel values that are raw brightness values (BV) (or digital numbers, DN), which represent the relative radiance of the surface in the given pixel in a given spectral band, to reflectance values between 0.0 and 1.0. This requires correction/removal of atmospheric effects and calibration of the brightness or radiance to reflectance by dividing it by the sun's irradiance on the surface in the given pixel (see the reflectance equation in Lecture 5). Thus, it is important to understand spectral reflectance in order to understand multispectral or hyperspectral imagery.

The goal of this portion of the lab is to develop basic understanding of field-based spectroscopy using a portable spectrometer by measuring the spectral reflectance of various surface types (e.g. vegetation, water, concrete, etc.). Additional goals are to become more familiar with the general procedures for collecting spectral reflectance, processing and using spectral data (e.g. calculating vegetation indices), and interpreting spectral reflectance of various surfaces types with respect to their absorption and reflectance features.

About the spectrometer

Our Analytical Spectral Devices (ASD) handheld spectrometer is capable of measuring EMR in the visible/near-infrared. Radiance incident to the instrument is separated into narrow spectral bands. The instrument uses a lens and detector with the same triangular geometry we discussed for remote sensors. We have lenses with 25° and 1° total angle of view. Therefore, radiance detected by the instrument represents radiance from the surface over a given area of the surface, which is dependent on the distance or height from the surface (as for a regular camera). If the Field of View (FOV) includes a mixture of land cover or target types, the resulting spectral reflectance curve may be difficult to interpret. Thus, it is important to ensure the FOV is covering pure (or as pure as possible) samples of the desired cover type.

We will also use a reference disc made of Spectralon, a synthetic material that diffusely reflects 99% of the irradiance to its surface across the visible-NIR spectrum. **It is important not to touch it or get it dirty.** Measuring its radiance with the spectrometer and then measuring the radiance of the target, allows reflectance of the target to be calculated simply as:

$$\boldsymbol{\rho(\lambda) = \text{Irradiance on detector from target} \div \text{Irradiance on detector from reference disk}}$$

Procedures for data collection

Reflectance properties of various surface types: (to be completed as a group)

- Collect spectral reflectance measurements of 2 **different non-vegetated surface types** (e.g. soil, concrete, etc.).
- Collect spectral reflectance measurements of 2 **different vegetation types** (or vegetation of different conditions).
- Download and store the output files (.txt) on your own device or the lab's computers. Then, transfer the data into an Excel file and follow the instructions to calculate the spectral reflectance of each ground target.

Questions

1. Plotting spectral reflectance signatures

a. From the spectrometer data, plot the spectral reflectance curves for the 2 non-vegetated target types and 2 vegetation types. Display all spectral curves on one graph (graphs should be properly labeled). **(3)**

b. What differences in reflectance do you notice between the 2 vegetation types? What physical or physiological factors could lead to the observed differences in spectral reflectance? **(2)**

Commented [DK1]: **Graphs should be assessed for accuracy, axis labels etc. They should follow the standard curves we would expect.**

Commented [DK2]: **Perhaps one has more of a defined green veg curve with higher green peak, deeper red trough, and steeper red edge and higher NIR reflectance than the other. See whether they ID any of these factors and link them to Chlorophyll absorption for photosynthesis and/or more scattering off cell walls in NIR (healthier veg), etc. Accept reasonable answers that attempt to give real reasons and are not wrong.**

2. Spectral derivatives:

a. From the spectrometer data extract the reflectance values for the near-infrared (NIR) and red (R) portions of the spectrum for each of the 5 target types. To do this, select an appropriate range of wavelengths within each of these spectral regions. Calculate the average reflectance value for each of these two spectral bands for each target type. Using these averaged NIR and R values for each target type, calculate the Normalized Difference Vegetation Index (NDVI). NDVI is defined mathematically as: **(5)**

GEOM 3002 Lab 5 (cont'd)

$$NDVI = \frac{NIR - R}{NIR + R}$$

Commented [DK3]: NDVI values should be assessed based on the TA's calculations from the same data.

b. Describe the differences in NDVI values you obtain for the various target types. Based on your answers, what values (or ranges of values) of NDVI do you think are typical for healthy green vegetation vs. other non-green vegetation targets? Describe briefly what spectral reflectance information a vegetation index exploits; i.e., why are they often ratios that include the NIR and R bands? **(3)**

Commented [DK4]: Answer depends on data used, but NDVI is higher for healthy vegetation than for other materials.

c. How can the information produced from indices, such as NDVI, be used to assess ecosystems? **(2)**

Commented [DK5]: Reasonable answers from texts and studies accepted. E.g., 1) Monitor change in global vegetation quantity like biomass, to see effects of climate change, forest cutting etc. 2) Monitor crop veg growth and predict yield; 3) monitor forest health and effects of diseases, insects and burns, etc.

<u>B. PCI Geomatica: Introduction to image display, processing and analysis</u> (27 marks)

<u>IMPORTANT 1^{ST} STEP IN ALL WORK:</u> Saving PCI (.pix) file: Log on to an available PC.
Go to S: Courses\GEOM 3002\Lab 5 and <u>copy the file Ottawa.pix to your memory key or personal folder</u>. Do not save to the C drive - it will not save your work when you log off.

Another important note: If PCI fails and will not re-start after you shut it down nor after you turn off your computer and re-boot, see John Milton in the office beside A237 during regular office hours (weekdays 8:30-4:30). If he is unavailable or it is outside regular office hours, email Doug and Emily. No-one will be penalized if there are technical issues, so please don't panic.

OK – let's get started!
Starting Geomatica: You can start PCI Geomatica by double clicking on its desktop icon, or by selecting it from the start menu, or by searching for Geomatica. The Geomatica toolbar (Fig. 2) should pop up and the module called *Focus* should open automatically (be patient). It is a primary entry point into many of Geomatica's algorithms. If the *Focus* module does not load automatically when you start PCI Geomatica, start it by clicking its icon on the Geomatica toolbar. Note that this toolbar also has a variety of other software modules that we will not use in GEOM 3002.

Figure 1. PCI Geomatica Icon

Figure 2. Geomatica Toolbar.

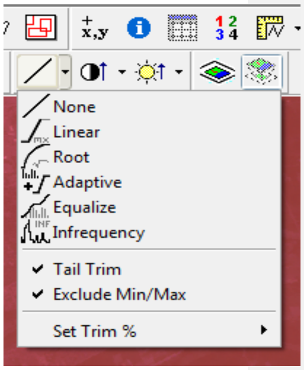
Once the Focus window is running, open the *Ottawa.pix* file that you have copied. Focus will then load the image file into the system and onto the screen. Maximize the window. Note: you can also open a pix file from Windows Explorer by clicking on it.

You will notice that when *Ottawa.pix* loads, it displays the first three 'channels' of the file automatically, assigning them the colours red, green and blue, respectively. In this case, the 1st three channels in the *Ottawa.pix* file are spectral bands of the Landsat-8 OLI sensor: Band 1 (displayed as red), Band 2 (displayed as green), and Band 3 (displayed as blue) - the colours that they are assigned are shown to the left of their names. You can immediately see that this is not a natural colour image as a deep blue spectral band (Band 1) has been assigned to the red display colour, the blue spectral band

(Band 2) has been assigned to the green display colour, and the green spectral band has been assigned to the red display colour. This is a 'false colour composite'. These band-colour assignments can be changed as we will do later in the lab.

Figure 3. If the file loads properly, the first 3 'channels' of *Ottawa.pix*, are loaded to the display and coloured red, green and blue, respectively.

Figure 4. Drop-down menu bar for Enhancements.



When the image appears in the image viewer it will most likely be automatically contrast enhanced using an "Adaptive" enhancement. Click "None" as shown in Figure 4. The image should become much darker. These are the original image brightness values as sensed by Landsat 8 OLI. Landsat OLI and other sensors record data with relatively low brightness to avoid saturation in areas of high reflectance. We'll come back to Contrast enhancement later in this lab.

Look at the other buttons on the toolbar. You will be using the <u>Measure</u>, <u>Numeric Values</u> and <u>Cursor Control</u> buttons (Fig. 5) later in this lab.

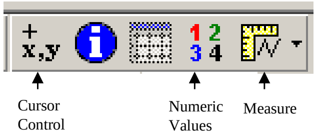


Figure 5. Numeric Values, Cursor Control and Measure Buttons.

The *Ottawa.pix* image is a Landsat-8 OLI scene of Ottawa, Ontario (August 18, 2013) that is projected to the UTM coordinate system, where ground locations are in metres. In the UTM projection, the x and y coordinate axes are referred to as Eastings (E) with respect to the western boundary of a given UTM longitude zone (Zone 18 for Ottawa) and Northings (N) as the distance north of the equator, respectively. Click your cursor around the image and you'll see the coordinates for its position at any pixel in the bottom left of the image window.

<u>Question 1: Spectral Bands and Image Display</u>

In Focus, you will see a Files tab and a Maps tab. The Files tab shows individual spectral bands and any other data in "channels". These can be displayed one at a time in greyscale or pseudo colour (see later in this lab), and processing can be implemented on any one channel. Processing a channel in the Files tab accesses the data directly from the stored .pix file and saves it back to the .pix file. The Maps tab is more for colour display, although processing and analysis can also be done in the Maps tab. It allows some processing to be done just on the displayed image (which may be re-sampled if the full image is very large), thus increasing processing speed and allowing the user to see the results on the screen before processing the data for the whole channel and saving it. We will use whichever is convenient in the steps below.

GEOM 3002 Lab 5 (cont'd)

Click on the Files tab (top left of Fig. 3), then click on the '+' sign beside "Rasters". A list appears that contains a description of all the data types that are associated with the *Ottawa.pix* image. Each spectral band is recorded by separate sensors so viewing an individual band in greyscale is often important to aid interpretation of image brightness in relation to surface reflectance. To display a single band in greyscale, right click on one of the spectral bands, then left click and select View, then As Grayscale. View the band with no enhancement, followed by each of the other enhancements (Fig. 4) to see their effects. We will discuss how these enhancements work in Lecture 6.

a. Display the red band in greyscale. Rank the following from brightest to darkest and briefly explain how these brightness values are related to red surface reflectance: water, the Ottawa airport runways, vegetation. **(1)**

Commented [DK6]: **Brightness increases with reflectance: runways brightest, vegetation 2nd brightest and water dark – same order for reflectance in this band**

b. What are the minimum and maximum wavelengths in microns (micrometres) that are sensed by the 2nd band of the mid (short-wave) infrared (Band 7)? **(1)**

Commented [DK7]: **2.11-2.29 µm**

c. Display a thermal infrared band as grayscale. What difference do you notice with Bands 1-8? What is the pixel size of the thermal IR bands compared to the bands 1-8? **(1)**

Commented [DK8]: **Fuzzier because 100 m pixel size vs. 30 m**

d. Do brightness values in Bands 10 and 11 represent reflectance? Explain. **(1)**

Commented [DK9]: **No. Emitted energy, heat. Greater (temperature or heat) emission or emittance,**

Question 2: Colour Infrared Composites

Click on the Maps tab, then left click on the RGB image. Holding the left mouse button down drag the image to the top of the list of images just underneath "New Area" (this brings it into the 'current' display). Show the list of spectral bands assigned to the display colours Red, Green and Blue (RGB) by clicking on the + sign beside the Ottawa.pix filename. This display should be the same as the one you originally had when you opened the file.

a. Right click on each colour in turn and change the assigned spectral bands to produce a standard colour infrared (CIR) composite. Fill in the table below with the bands that you assigned to the RGB display channels. **(1)**

	Blue display colour	Green display colour	Red display colour
Spectral Band	**G (3)**	**R (4)**	**NIR (5)**

Enhance this CIR composite with a linear contrast enhancement.

b. Why is water so dark? **(1)**

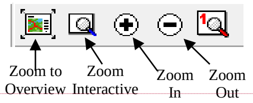
Commented [DK10]: **reflects very little EMR in the spectral bands of the display, (especially NIR)**

c. For areas that appear Cyan (turquoise colour that is a combination of blue and green), the spectral band in which they have relatively low reflectance is:
band- 1 / 2/ 3/ 4/ **5**/ 6/ 7/ 8/ 9 / 10 / 11 **(1)**

d. Click on the cursor control (Fig. 5) button on the toolbar. Type the coordinates 456972 E and 5022721 N into the UTM coordinate boxes, and close the cursor window. The cursor should now be at these coordinates in the image - do not click within the image or the cursor will move. At this scale the cursor may not be visible so Zoom in using the '**+**' button (Fig. 6) – the zoom will occur with the cursor at the centre of the window. What is the land cover type? **(1)**

Commented [DK11]: **Bare soil;**

Figure 6. Zoom tools.



GEOM 3002 Lab 5 (cont'd)

Explain how you determined that by referring to one distinctive element of interpretation. **(1)**

Commented [DK12]: **Tone is bright. (0.5 for shape – rectangular, so agricultural field – which is a land use, not land cover)**

More on False Colour Composites: On the MAPS tab, experiment with changing the RGB display colours to any of the other bands to produce your own false colour composites (select linear contrast enhancement each time). Note what colours the major land cover types (vegetation, soil, water urban) become in these composite images.

As for Cyan above, remember that Yellow is a combination of R+G display colours and Magenta is a combination of R+B display colours. The trick is to look at the image colour; if it is Y, M, or C, then it is a mix of two display colours. This means the feature has high reflectance in the two spectral bands assigned to those two colours, <u>and has relatively lower reflectance in the spectral band assigned to the third display colour</u>. Similarly, white in the image means the reflectance in all three of the displayed spectral bands is about equal and high. Overall, remember that <u>the image colours do not represent the reflectance in those colours (RGB) but represent the reflectance in the spectral bands assigned to each display colour. The only exception to this is a natural colour composite where red, green and blue spectral bands are assigned to the R, G, B display colours, respectively.</u>

Question 3: Viewing Pixel Brightness Values

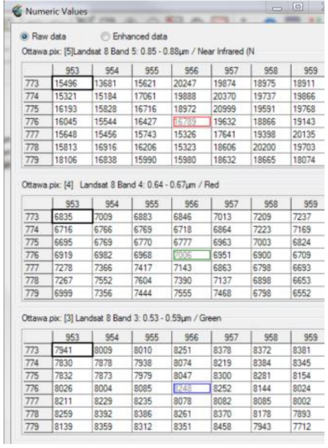
Move your cursor to a location that has either a thick forest or green crop cover. If you are not currently zoomed in on the feature, do it until you see individual pixels - notice how they vary in brightness and colour. Zoom back out to the original resolution. You can do this using the zoom to overview or the zoom out tools (Fig. 6).

You can view the actual digital values of the pixels at and around your cursor by clicking on the <u>Numeric Values</u> (Fig. 5) toolbar button and reviewing the information in the <u>Numeric Values</u> data box (Fig. 7). Numeric Values show the pixel brightnesses in given spectral bands either for raw or contrast enhanced data at and around the cursor's location.

a. Make sure that you still have the colour-infrared composite displayed (see Q2). Give the northing and easting of your cursor position and list the raw brightness values at the cursor pixel in each of the three spectral bands. **(1)**

Accept any values with NIR > R,G unless they seem way off – then check them.
APPROX RANGE:
NIR 17000-30000 (Lower end for forest, higher end for crop);
RED 6500-6800 (higher end for forest; lower end for crop);
GREEN 7600-8700 (Lower end for forest, higher end for crop).

Figure 7. Numeric Values data.



● Raw data ○ Enhanced data

Ottawa.pix: [5]Landsat 8 Band 5: 0.85 - 0.88µm / Near Infrared (N

	953	954	955	956	957	958	959
773	15496	13681	15621	20247	19874	18975	18911
774	15321	15184	17061	19888	20370	19737	19866
775	16193	15828	16716	18972	20999	19591	19768
776	16045	15544	16427	16789	19632	18866	19143
777	15648	15456	15743	15326	17641	19398	20135
778	15813	16916	16206	15323	18606	20200	19703
779	18106	16838	15990	15980	18632	18665	18074

Ottawa.pix: [4] Landsat 8 Band 4: 0.64 - 0.67µm / Red

	953	954	955	956	957	958	959
773	6835	7009	6883	6846	7013	7209	7237
774	6716	6766	6769	6718	6864	7223	7169
775	6695	6769	6770	6777	6963	7003	6824
776	6919	6982	6968	7006	6951	6900	6709
777	7278	7366	7417	7143	6863	6798	6693
778	7267	7552	7604	7390	7137	6898	6653
779	6999	7356	7444	7555	7468	6798	6552

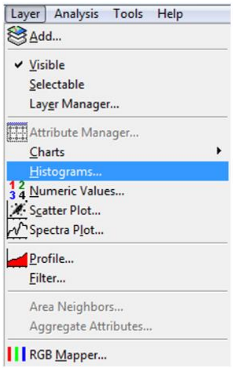
Ottawa.pix: [3] Landsat 8 Band 3: 0.53 - 0.59µm / Green

	953	954	955	956	957	958	959
773	7941	8009	8010	8251	8378	8372	8381
774	7830	7878	7938	8074	8219	8384	8345
775	7832	7873	7979	8047	8300	8281	8154
776	8026	8004	8085	8248	8252	8144	8024
777	8211	8229	8235	8078	8082	8085	8002
778	8259	8392	8386	8261	8370	8178	7893
779	8139	8359	8312	8351	8458	7943	7712

Question 4: Image Histogram Display and Analysis

Figure 8. Layer menu.

GEOM 3002 Lab 5 (cont'd)



Using your CIR composite, we will now view the histograms of each spectral band. First, zoom the display out so you can see the whole image. Then, select Layer (Fig. 8) on the top toolbar, and select Histograms. A window should appear entitled *Multi-Histogram Display*.

The x-axis is image brightness in DN (theoretically for 16-bit data). Note: Landsat 8 OLI data are 12-bit but they are encoded to 16-bits (2 bytes). The Landsat 8 range of brightness values (as digital numbers or DN; 2^{12}= 4096DN) has been stretched within the 65536 DN range of the 16-bit (2^{16}) encoding. The y-axis is a scaling factor showing the % of total pixels in the image. These histograms tend to display as too small, but if you click on each histogram an expanded version is displayed with the y-axis as the number of pixels for each DN brightness value. Make sure that the mask option has "entire raster" selected. You can quickly see the relative brightness of each band and if the data in each band are normally distributed (bell-shaped) or some other shape. For example, we can immediately see that the NIR band is brighter overall than the two visible bands in the display.

The NIR band also has a number of pixels on the left side that are very dark, indicating low reflectance. What land cover type do they represent? **(1)**

Commented [DK13]: **Water**

Look at the number of pixels, mean, median, minimum DN, maximum DN, and standard deviation for each of the spectral bands.. Note: these histograms can also be accessed by right clicking on the filename (Ottawa.pix) in the Maps tab, or by right clicking on a given spectral band under the Files tab. This is similar for many Geomatica functions; they are accessible in several different ways.

a. In the files tab, view Band 8 as grayscale. Why is this image sharper than the others? **(1)**

Commented [DK14]: **10 m pixels**

b. View the SWIR 1 band in grayscale and display its histogram. What are the mean, maximum, minimum and range of brightness values for this image? **(1)**

Commented [DK15]: **11726.6, 56620, 4605, 52015**

Assuming the brightnesses in this image represent a surface reflectance range from 10-60%, how much reflectance (in %) does each brightness value (DN) represent? Show your calculations. **(1)**

Commented [DK16]: **50% ÷ 52015= 0.00096% per DN**

You can also run your cursor over the histogram to find out how many image pixels have a certain brightness value. Or, you can hold down the left mouse button and draw a rectangle in the histogram to zoom in on a portion of it, or right click and zoom in and out.

Question 5: Image Contrast Enhancement

In the files tab, view the NIR band as grayscale. Starting with no contrast enhancement (Fig. 4), cycle through each enhancement to see their effects.

a. Describe the visual effects of the root and histogram equalization enhancements on the viewed image (i.e., what do you see has changed in terms of image brightness; do not describe how they work for this question). **(2)**

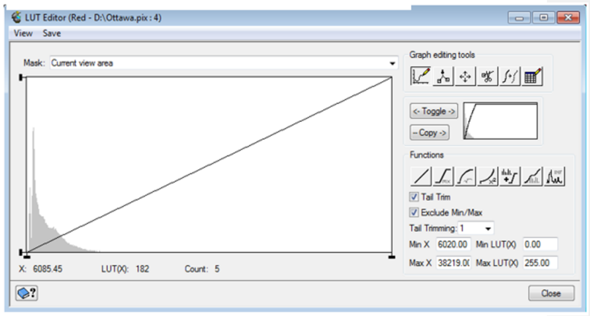
Commented [DK17]: **Root: water very dark, all other areas are in a compressed range and bright**
Histogram equalization: Contrast between bright and dark is greater; brights are brighter, darks are darker, much more detail visible. – accepted any reasonable answer along these lines.

Display another spectral band as grayscale (select one different from your neighbour). Make sure that the image is not enhanced (enhancement is None).

GEOM 3002 Lab 5 (cont'd)

To graphically view the effects of an enhancement on a single spectral band, click on the Maps tab, then, if it is not at the top of the list and displayed, left click on it and drag it to the top of the list (– the Maps tab display only shows the image at the top of the list). Right click on the spectral band and select Enhance, then select Edit LUTs from the drop-down menu. A histogram will appear. Click on the histogram. A window entitled *LUT Editor* (Fig. 9) should appear.

Figure 9. LUT Editor.



Mask: Current view area

☑ Tail Trim
☑ Exclude Min/Max
Tail Trimming: 1
Min X 6020.00 Min LUT(X) 0.00
Max X 38219.0(Max LUT(X) 255.00

X: 6085.45 LUT(X): 182 Count: 5

This window allows us to graphically view any enhancements that we make to the non-enhanced image in terms of the function (line) that relates the original image data (x-axis) to the output image data (y-axis). You should see a grey histogram with a straight line running through it from the bottom left to top right. If the line doesn't go to these corners, ensure that no enhancement is selected.

If you start to click on the Functions buttons, you will see the effects of those enhancements on the image. The enhancements correspond to (from L to R): None, Linear, Root, Square, Adaptive, Equalization, and Infrequency. If you want, look in your lecture notes and in PCI Help "Using Raster Toolbar Enhancements" to see how these functions work. For example, if you click the 3rd from left button, you will see the effects of the Root enhancement you visually assessed above. This is a non-linear enhancement that takes the square root of the image brightness values and then linearly stretches the result into the full data range (0-65535DN for these data). The line shows the mathematical function relating the input image brightness values to the output brightness values. The original image histogram is shown in gray underneath.

b. Note that you can also click your left mouse button on the black line and drag it anywhere to create a custom (and sometimes very strange) enhancement function to an image. Try this and produce an enhanced image that uses a non-linear or piecewise (see lecture notes) type of enhancement function (again, make sure your image is at the top of the list in the Maps tab in order to see the changes in real-time). Remember from Lecture 6 that an LUT is simply a look-up table of input brightness in one column and the corresponding output brightness in another column. A custom function you create through the above process simply creates a new LUT that can be applied to the original image to produce a transformed image. If you want, you can also move the slider tabs at each end of the x-axis inward to enhance only a portion of the image data as we discussed in class (using +/- 1 std. deviation). Submit a screen shot of your final custom enhancement LUT panel and the resulting image. **(1)**

Commented [DK18]: **Check to make sure done correctly.**

Note: if a long list of images accumulates in the Maps tab, you can remove any one of them by right clicking on the file name and selecting Remove from Area.

Question 6: Pseudocolour Display

Click on the Files tab, extend the Rasters list, then select Channel 11 (TIR 2 band). Use the right mouse button to select View (as pseudocolour). The data should appear multi-coloured on your screen. Make sure that the image is not enhanced (enhancement is None). This type of display is useful for gradients such as temperature or elevation.

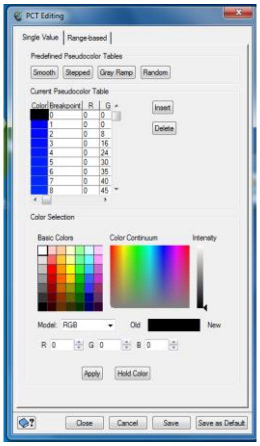
GEOM 3002 Lab 5 (cont’d)

Right click on the same image in the Maps tab and select Edit PCT. The PCT Editing box will open. A pseudo colour table (PCT) is a type of LUT giving an output brightness for each of Red, Green, and Blue in a colour image that is being created from a single greyscale image or raster input. Notice there are Single Value and Range-Based tabs at the top (Fig. 10).

Under the Single Value Tab, describe the effects of 'smooth, stepped, grey ramp, and random' on these data by selecting each (i.e., the 4 Predefined Pseudocolor Table buttons). Use the vertical scroll bar to scroll through the colours/tones associated with representing each DN value. **(4)**

Different methods for assigning colours or grey tones to pixel values. Smooth is a gradual variation in colour hue as grey level increases or decreases, stepped has breaks and assigns a group of hues (e.g. reds) to a given pixel value range, grey ramp assigns shades of grey to pixel values so brighter are higher, and random uses a set of RGB values which has been randomly picked to assign to the grey levels.

Figure 10. PCT Editing.



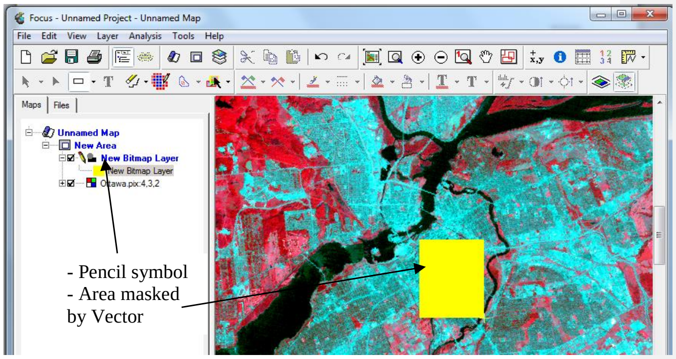
Color	Breakpoint	R	G
⬛	0	0	0
🟦	1	0	0
🟦	2	0	8
🟦	3	0	16
🟦	4	0	24
🟦	5	0	30
🟦	6	0	35
🟦	7	0	40
🟦	8	0	45

R 0 G 0 B 0

Question 7: Scatter Plot Analysis and bitmap masking

Remove the pseudo-coloured image and re-load a CIR composite image. We can assess the correlation between each of the spectral bands in the data set; this gives an idea of whether the bands represent independent (low correlation) or redundant (high correlation) information. This type of analysis is useful in thematic mapping of land cover (see Labs 7 and 8) and image statistical analysis/modelling (see GEOM 4003). We will assess band correlations for two sub areas in the image representing two land cover types. This can be done by outlining a ’bitmap’, a solid polygon represented by DN = 1 that allows analysis of the data within the polygon.

Figure 11. Pencil symbol and the bitmap rectangle.

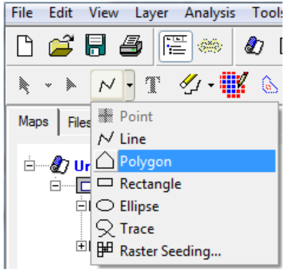


Select an area representing only urban land cover (try not to select the exact same area as your neighbour). To create a bitmap mask within this area, go to the Maps tab, then right click “New Area” and add a “New Bitmap Layer”. Press OK to close the window. Make sure the “Pencil Symbol” is beside the New Bitmap Layer (Fig. 11). Left click once on the bitmap layer and using the Vector “polygon” drawing tool (Fig. 12), draw a polygon over your selected area. Click once to create vertices, twice to close the polygon and fill it. Next, right click on the “New Bitmap Layer” and select Save; browse to select your Ottawa.pix file, then save the bitmap. You have now created a bitmap mask. Note – students often have trouble with the above steps; make sure you do them correctly.

GEOM 3002 Lab 5 (cont'd)

You will next assess the correlation between each of the spectral bands in the area represented by the bitmap. To do this, right click on the Ottawa.pix image in the Maps tab, then select <u>Scatter Plot</u>. A window should appear with a scatter plot in it. The scatter plot will have a black background and be hard to visualize so, if you want, change the background colour using the "Graph Controls" button at the bottom of the Scatter Plot box. For "Mask", select your new bitmap layer (Fig. 13). This will display the image data only for the area within your bitmap.

Figure 12. Vector Drawing Tool.



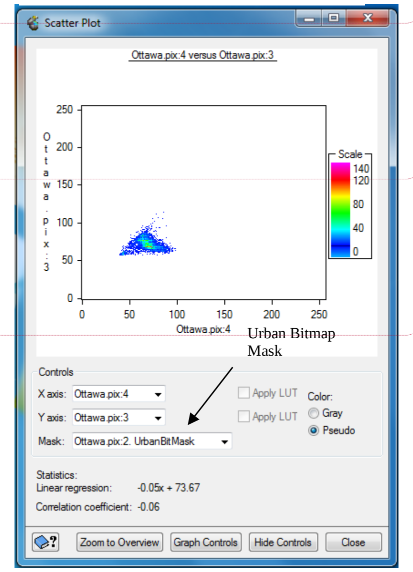
At the bottom of the window is the correlation coefficient between the bands being displayed on the scatter plot. Note it on a piece of paper or in your report draft. You can change the bands and note the correlations between all possible band pairs and produce a correlation matrix (see Lecture 6 slides).

Repeat the above bitmap mask procedure and correlation analysis for a subarea representing vegetation only. Note: In the scatterplot graph, if the data plot only to one corner, you can draw a rectangle around them to zoom in on them.

a. Produce a correlation matrix for the urban subarea and vegetation subarea showing the correlation between each pair of bands 1-8. **(2)**

Commented [DK19]: Check correlation matrix for correct layout and values.

Figure 13. Scatter Plot.



X axis: Ottawa.pix:4
Y axis: Ottawa.pix:3
Mask: Ottawa.pix:2. UrbanBitMask
☐ Apply LUT
☐ Apply LUT
○ Gray
● Pseudo

Statistics:
Linear regression: -0.05x + 73.67
Correlation coefficient: -0.06

b. Describe what the following mean: i) a correlation close to +1.0; ii) a correlation close to -1.0; iii) a correlation close to 0.0. **(3)**

Commented [DK20]: r close to 1: highly positively correlated, as one increases so does the other
r close to -1: highly negatively correlated, as one increases the other decreases
r close to 0: not correlated, changes in one unrelated to other

c. From your vegetation correlation matrix, which two bands are most correlated and which two bands are least correlated? **(1)**

Commented [DK21]: Most correlated is highest whether + or –
Least correlated is closest to 0, whether + or -