GEOG357: Fall 2020 Lab 1
Geomatica Banff: Image display and Digital numbers (DN)

This lab explores the Geomatica Banff interface, display options and examining the DNs that make up satellite image bands, for Landsat 5 Thematic Mapper, and Landsat 8 OLI data

All data for the course are stored in this folder: /home/labs/geog357

Software: Geomatica by PCI Geomatics, Toronto
The native format for PCI images is **.pix** (though you can load other formats)
.pix files   can hold many image bands, other layers including vectors

0. Login using your UNBC login and password – via VPN2 or VMware

connect to the GIS Lab windows server at osmotar.gis.unbc.ca

if asked for domain, this is uni

The osmotar desktop should look the same as if you are in the lab – note that it has changed since previous semesters, with new servers and also software versions.

Reminder of Landsat 5 bands:
Landsat TM: Visible: 1,2,3 (Blue, Green, Red)   Near IR: 4 Mid-IR: 5,7   Thermal IR: 6

Thematic Mapper (TM)	Landsat 4-5	Wavelength (micrometers)	Resolution (meters)
	Band 1	0.45-0.52	30
	Band 2	0.52-0.60	30
	Band 3	0.63-0.69	30
	Band 4	0.76-0.90	30
	Band 5	1.55-1.75	30
	Band 6	10.40-12.50	120* (30)
	Band 7	2.08-2.35	30

Note the difference throughout between RGB – the display guns and the image bands (1-7)
Image Bands: Refer to the individual Landsat TM bands ranging from 1 -7.
Channels: the database layers -initially the same as the band numbering
Display guns (RGB): three planes can be displayed simultaneously in red-green-blue (RGB).
Displaying the same band or channel three times in RGB produces a gray tone image.

Questions: Any questions posed in this lab could be part of assigned questions in next weeks – just be sure you can answer them …

0. Start Geomatica Banff software

Select only the 'Focus Banff ' option– this is a bit like ArcMap within ArcGIS; we might need some of the other modules, but mostly we'll use Focus from the Geomatica suite

size the 'Focus' window – I prefer not to maximise but to custom enlarge with the corner arrows

All files for this lab (and future labs) are in the folder*: /home/labs/geog357*

1. Color Image Display and Set-up

Loading Satellite Imagery in Focus
☐   **file -> Open** and select: **pg14sept2011.pix**
☐   The filename is self-explanatory – the date the image was captured
      The scene has been clipped to reduce size and the need to pan a lot
☐   Resize to get best display .. you should be able to see almost the whole dataset without panning; resize by extending the corners, but I recommend you don't maximise the window. The pixels are 30 x 30 metres in size – standard for most Landsat imagery

a. Display and Enhancement

The initial display usually has poor contrast; default bands 1-2-3 are in R-G-B ('reversed': blue band is shown in red, red in blue) -> 'flip' bands 1 and 3 by:

right-clicking filename in 'Maps' tab and **RGB mapper** - click 3 in red and 1 in blue (close)

Enhance: right-click -> enhance - root- usually works best (or linear)

You can also enhance using the icon in the 2nd row along the top under the 'scissors', and left of the sun and shade icons

a. Zoom and Pan – + and - zoom in and out, but more useful, use the box symbol to the left of + to outline an area of interest (same as in ArcMap); check out the campus and your house areas; zoom enough to see the pixels. Zoom back out to original using right-click -: Overview of Layer

b. Note the UTM coordinates (displayed at the bottom) as you move – scenes are downloaded in the local UTM zone; see Lat/long as well for a point by clicking the +x,y button – *what is the approx. lat/long of UNBC ?*

c. Measure the approximate E-W and N-S extents .. use the measuring tool (top right), or use basic math from the UTM coordinates; how big is it across in kilometres ?

d. Enhance – try linear and root – see which gives best contrast. Enhancements will be based on what is displayed onscreen and need re-doing each time you change the display:

e. You can also find many tools using right-click on filename

Note below also the DN values (0-255) at the cursor position for the bands displayed (in R-G-B)

Change the display to 'false colour'
>   The image has fair haze in the NW corner, we can reduce this adding the near-IR band

- Right-click on filename and select RGB Mapper again
- Move the check boxes to 4-3-2 and enhance - root again [you always need to as the display is based on the previous data display]
- Now change to 5-4-3 maximum contrast in the same way (and enhance again)
- We can compare the 5-4-3 and 3-2-1 displays more easily by adding a new layer
- Layer-add-> RGB and in the 'wizard pop-up box' click on 3 then 2 then 1, finish -> and as always, enhance
- Now click the normal colour display on and off to compare with the 543 - note the contrast in the 543 and advantages of using IR: veg contrast, land v water, no haze.

2. View the individual bands in grayscale:

Layer-add-grayscale; select band 1 and finish

Right-click on the grayscale layer in the Maps list and select RGB mapper – note that all 3 colour guns are ticked for Band 1; change this to band 2, close and enhance as needed.

Do the same to view bands 3-7 (always enhance as needed)

Note that bands 1-3 are similar, bands 5 and 7 are similar, band 6 is 'fuzzy' – larger pixels.

Maps and Files tabs

On the left in the 'TOC' you see two tabs: maps and files. The default is maps, which enables display options, while files shows database information.
[For GIS geeks, you could think of them as parallel to ArcMap and Catalog].

Switch the tab to files and right-click on the filename.
General – file size etc..   History and metadata – none given
Projection –   UTM and 30m (pixel size)

Check rasters .. it will list the bands / channels available (7)
Switch tab back to maps

3. Examining histograms

Highlight the 321 display layer name and View the histogram by selecting:
Right-click on filename -> histograms   OR select (in menu bar at top) **Layers -> Histograms**

This displays the histograms for the selected RGB (note that all operations relate to the layer highlighted in the TOC, not the one displayed, unless they are the same.

Get more detail and information for each one by clicking on its histogram (yes, try it!)

Note (as in lectures): the 3 histograms are similar in shape (all are visible bands);
All have a low range of values compared to the 0-255 possible range
Also. the minimum DN decreases as wavelength increases as bands are less affected by haze -
haze adds fake 'brightness' so there are no pixels with lowest values, especially for blue

Now highlight the 5-4-3 composite display
View the histograms for this composite
Note the differences in shape, and how the IR histograms are 'bimodal' (why ?)
Answer - because water is very different in IR, but not in the visible bands
Check this out by clicking your mouse in water, view the DNs at the bottom

right-click on filename and this time select 'numeric values' – this gives you the DNs for the 7x7 grid around the mouse location – these can be handy for local investigation.

4. Add a second image (1996)

File->open and select **pg11sept1996.pix**
Switch the bands to 5-4-3 and enhance
Compare with 2011 - they should line up perfectly
You can easily see some changes - changes to the UNBC campus e.g. the Northern Sports Centre and other buildings/roads; also the expansion of the runway at the airport - now the 3rd largest in Canada ! There are many forest changes with cutblocks and regrowth etc..

As well as a visual change, check the DNs and compare - do this by clicking on a point, and then simply highlight the other scene data in the maps tab ... watch the DN display at bottom change - which band is changing most for a feature/area that has changed ?

Do this for other locations e.g. another cleared area, and an area with little change - is one band changing more than the others ? We may use this info later in the change detection lab.

5. Image interpretation

The best overall combo is one band each from the visible, near-IR and mid-IR e.g. 543 or 742
543 is generally the most commonly used;
In the 5,4,3 or 742 colour composite for 2011 - note the following general colours:

- Dark-green: coniferous.
- Light-green: deciduous.
- Pink: arable / agricultural.
- Dark-purple: industrial.
- Light-purple: residential.
- Black: deep or sediment-free water.
- Blue: shallow or sediment-laden water.

Click with your mouse on a sample location of each of these to see why the colours appear as
they do … a combination of RGB, and whichever bands are in those colour guns.
Remember that Near IR indicates vegetation vigour / health, high DN = healthy vegetation
Mid-IR indicates dryness (lack of moisture) ; high DN indicates low moisture
First select the chip piles at Canfor (brightest place on the image) … they are bright (white) as
they reflect high in all 3 bands

Shadows: Check out the esker ridges north of the Nechako ~UTM 509000, 5982900 and
inspect the DNs in the shadows vs the illuminated south facing slopes – how different are they?

6. Landsat 8 OLI - 3 September 2013

We will add an image from 2013 and shift to Landsat 8 OLI data, with more bands than
Landsat 5, and 16-bit data so DNs are now potentially 0-65,535; there is also a higher
resolution Panchromatic band (15 metres)

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Ultra Blue (coastal/aerosol)	0.435 - 0.451	30
	Band 2 - Blue	0.452 - 0.512	30
	Band 3 - Green	0.533 - 0.590	30
	Band 4 - Red	0.636 - 0.673	30
	Band 5 - Near Infrared (NIR)	0.851 - 0.879	30
	Band 6 - Shortwave Infrared (SWIR) 1	1.566 - 1.651	30
	Band 7 - Shortwave Infrared (SWIR) 2	2.107 - 2.294	30
	Band 8 - Panchromatic	0.503 - 0.676	15

File-> open   **pg3sept2013.pix**

Band 1 is extra compared to Landsat 5 TM ('Coastal blue') - note that the bands are nicely described with Landsat 8 so you know what they are. The standard RGB natural colour is now bands 4-3-2 but some displays already know this
Ensure you have 432 displayed and enhance - note the DN display at bottom - now in 16-bit
View the histograms – they will look different with the 16 bit DNs.
What is the general range - ignoring the outlier values in long statistical tails ?

Change the band combination to 654 (=~TM543) enhance and view these histograms
- remember to click on each one to expand and see the proper details. Now query the DNs in

a. water   b. coniferous   c. deciduous

you should appreciate why these relative values represent these types of features in visible, near and mid-IR, though its more complex than with the simpler Landsat 5 TM 8-bit data.

Lastly, display the panchromatic band in grayscale:
Layer->add and select **pg3sept2013pan.pix**   enhance (you should know this by now!)
The pan band needs its own file, as it has higher resolution; flick from this to the colour composite to see the effect of the higher resolution in terms of detail e.g. UNBC campus.

You may have noticed that the RGB mapper shows bands for all files loaded – this can get confusing if you load too many – I wish PCI had a better way to do this.

7. Adding vectors

Yes, Geomatica is mostly about images, but can display vectors. We will add vector layers for the rivers and the city boundary:
Layer dropdown -> add -> vector -> next
Browse button -> navigate to **/home/labs/geog357/shapefiles** and click on **rivers.shp**
In the panel below, click on 1 (VEC) rivers   click on Finish, and Rivers will appear (in red)
To change colour, right-click in TOC vectors, colour -> blue
Repeat process for the **city boundary   (pgcity)**

You could here with two options:

a. you could open any of these images in ArcMap or QGIS – they will read the .pix format, but it's not as easy to enhance and perform other raster operations, including enhancements. We also do this in later labs

b.If you didn't get out much over summer (like me), you can take a virtual trip to Bowron Lakes.

8. A more exciting mountain image scene – Bowron Lakes

I'd suggest starting a new project : file-> new project
It will prompt you if you want to save the current project. You don't need to, as all you've done is display layers, but if you want to you can save a project as .gpr which is like an ArcMap .mxd – it simply records how things were set up.

File-> open and open *bow17aug1992.pix* and repeat the steps taken earlier to enhance the PG area display. Best bands etc .. but for a mountain area. Note how cleanly the 543 combo highlights glaciers in blue.

you can also open *bow19aug2016.pix*
so like PG, you have an earlier Landsat 5 image and more recent Landsat 8 image.
Enhance so they have similar contrast and band combos and note the changes over 24 years

That's it for now. Next week, we'll use these DNs to classify an image into land cover types. Close Geomatica Banff and Exit Osmotar and the UNBC desktop.

Grab a coffee, and see you tomorrow at the lecture.