

GEOG 357: Fall 2023

Lab 1: Introduction to PCI Catalyst / image data

Learning Outcomes:

- Login to the GIS lab computers and get a bit familiar with the Catalyst RS software
 - First look at imagery and the Digital Numbers (DN) that make up an image bands
 - A brief walking tour to review land cover and RS reflections
 - No lab question/answers need to be submitted this week
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1. General GIS lab access

Your names will be sent to Facilities so your student card will provide access outside lab times. The lab is only busy (full lab sections) for one other course (GEOG 204) Monday/Tuesday 11.30-14.20, though there may be empty seats towards the end of those sections. Other labs have fewer students and you can enter the lab without disturbing the class, by sitting towards the back. The lab schedule is posted outside.

2. Catalyst tool bar exploration

Once you are logged in, use the Catalyst icon or use the start button and (start to) type Catalyst (it will find it after ca...).

The Catalyst professional task bar appears with 10 options – we'll likely only use the first - 'Focus' which automatically opens an image window. As with other courses, your home folder is on K: and lab data on L: ... all data for the course will be stored in (Labs) L:\GEOG357.

Create your own geog357 folder for the course; copy this file: **pg14sept2011.pix** to your folder

This was one of the final images acquired on Landsat 5, at the end of its lifetime.

3. Loading satellite imagery

file -> open -> **pg14sept2011** - your copy, not the original in L:

The native raster file format for this software is **.pix** although it can also open standard raster files e.g. tif

It is a powerful format that can contain many layers, both raster and vector

The filename is self-explanatory – the date the image was captured. The scene has been clipped to reduce size and the need to pan / zoom as much. The pixels are 30 x 30 metres in size – standard for most Landsat imagery: In this case, it is Landsat 5, which you would know from the dates of data availability – only Landsat 7 was also operational then, but with lost data through striping.

Resize

For best display, you should be able to see most of the whole dataset without panning; resize the image window - I prefer NOT to maximise as then you have no other display space except monitor 2..

Satellite Imagery review: 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)
Your default opening image displays Band 1 in red, Band 2 in Green and Band 3 in Blue

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 will produce a gray tone image

There are 2 tabs in the top left - Maps and Files - for now ensure the Maps Tab is active

4. Basic image display

a. Display Options

The 'RGB' image opens with the first band layer in Red, the second in Green and the third in Blue. However for Landsat, and most imagery these are the blue, green and red bands so they are in reverse order (nearly all software does this e.g. ArcGIS, QGIS), so the first task is to 'flip' bands 1 and 3 into their proper display sequence – Blue band in Blue, Green in green, Red in red.

Right-click (rc) on the filename in the list of contents, and select RGB mapper. In the table move the 'ticks' to put bands 321 (red, green, blue respectively) in the RGB display and close. Now the display may look rather odd – because it based the colours on the first layers and they have changed. You will ALWAYS need to 'enhance' (as below) when you change the input layers.

b. Enhancement

right-click filename → enhance → root or linear (usually works best)

See which gives best contrast. Usually, Linear seems best in mountain scenes, and root in urban.

The enhancements will be based on what is displayed onscreen. No data numbers will be changed by enhancement, only how the imagery looks. Hopefully you can recognize some of the features on the display – e.g forest v fields, industrial v residential. Notice also the different colours for the Nechako (clear water) and Fraser (silt, mill effluent?). You can also enhance using the icon in the 2nd row below the scissors icon – Usually I find that one more convenient (which is why it is there !

c. Zoom and Pan

Use + and – to zoom in and out, and more useful, use the box symbol to the left of + to outline an area of interest (same as in GIS software); check out the campus and your house areas; zoom in enough to see the pixels. The next box to the left zooms back out to full extent (same as rc -> overview of layer).

d. View coordinates

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 lat/long of UNBC ? Note that the 4 decimal second places are 'precision overkill' as each pixel is only about 1 second (30m) across.

e. Digital Numbers (DN) values

The DN values (0-255) at the cursor position are given for the bands displayed (in R-G-B). These represent the 'brightness' or level of reflection (in this case in a range from 0-255).

f. Measure distance

Measure the approximate E-W and N-S extents using the measuring tool, [or use basic math from the UTM coordinates]; what is it across in kilometres? value is shown in metres, so divide by 1000

g. Changing the bands displayed

You already flipped bands 1-3 – the visible bands; now change the display to include the near-infrared band (4): RC-> RGB Mapper and show 4-3-2 in RGB and ENHANCE
This will simulate the “false IR look” to show healthy vegetation in red.

One step more: change the RGB mapper again to display 5-4-3 in RGB (and ENHANCE).
This is our **optimal display for maximum contrast** showing vegetation health and dryness. This should be the ‘default’ or best display for almost any image scene.

For an easier comparison with ‘natural colour’, we can reload the layers 3-2-1 in RGB using layer-add-RGB-next, and select 3-2-1 – finish (enhance as needed); you can now more easily compare the 543 and 321 colour composites by clicking the top one on and off. The 543 is superior for natural habitats, but may hold less advantage in urban landscapes.

Zoom in on the N-S service road behind the EFL (Enhanced Forestry Lab) – note that the road is not super visible as it is a lot less than 30m wide, note that it’s more visible on the 543 combo than 432 or 321, showing the higher contrast in the IR bands, but it would be more dramatic if the road was wider – possibly too it straddles 2 pixel width mixing with some vegetation, instead of being focussed in one pixel width. Band 3 (B display) is visible reflectance; band 4 (G) is near-IR = vegetation health; band 5 (R) is dryness (‘negative moisture’).

Click on Shane Lake to see much lower DN values – and thus why it displays in black.

We can maybe do a wee walkies outside this week or next to get a better idea of how we see image features as we do on satellite imagery.

h. Maps and files tabs

On the top part of the left panel you can see two tabs: maps and files. The default is maps, which enables display options, while ‘files’ shows database information. (For GISgeeks, you could think of them as parallel to ArcMap and Catalog. – and the new equivalents in ArcGIS and QGIS)

Switch to files tab

Click raster → it will list the bands / channels available (7)

→ right-click filename → properties

You see much fewer options than when you right-click in the maps menu

General gives file size etc.

History and metadata – none given

Projection – UTM with corner coordinates and pixel size: 30m

Click back to the Maps tab

5. Data and displays

a. Color Image Display

The DN values displayed at the bottom – they will be for the highlighted layer. You may need to highlight the layer you want, or you could get the last layer activated. This is the same in GIS software where you don't always query the layer you intend. Flip between the 321 and 543 displays to see their range of numbers – we mostly did this above.

b. View the individual bands in grayscale:

Layer-add-grayscale-next; select band 1 and finish .. and as always enhance if needed

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. Some striping will be evident from the low contrast and limited data range in band 6, and somehow, I lost a wee chip in the SW corner (no data)

c. Examining histograms

Highlight the 321 display layer name and View the histogram by selecting:

Right-click -> histograms OR select (in menu bar at top) **Layers -> Histograms**

We will discuss these in lecture tomorrow.

This displays the histograms for the selected RGB (note that all operations relate to the layer highlighted in the TOC, not always 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: 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 – which 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

Generally, higher SD = higher contrast; The standard deviation value is an indication of data spread (lower for Visible), and the bimodal graphs for IR reflect the very low DNs for water.

Check this out by clicking your mouse in water, view the DNs at the bottom

The lowest SD is for Band 6 – a very narrow range, and there are 0 values only due to missing data (the black wedge in the SW corner) – I'm not sure how I created this !!

Local DN values: 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 investigations.

6. Adding vectors

RS is mostly about images, but we can display (and also create) vectors. We will add a vector layer for the rivers:

Layer dropdown -> add -> vector -> next

Browse button -> navigate to **L:\GEOG357\shapefiles** and click on **rivers.shp ...** Open

In the lower panel, click on 1 (VEC) rivers

You may get a warning that the projection does not match exactly, but if so, click on OK
click on Finish, and Rivers will appear (in red)

To change colour, right-click in Table of Contents vectors, colour -> blue

You may see some mismatch between the vectors and image where either the rivers have changed and there are seasonal exposed sand banks or as a result of pixel size – as the city vectors were created from higher resolution aerial photography.

Repeat the process to add the **city boundary (pgcity)** – **and edit the colour if you wish**

7. Landsat 8 (OLI) - 3 September 2013:

Copy this file into your folder from **L:\GEOG357\pg3sept2013.pix**

We will add an image from 2013 – the year Landsat 8 was launched and shift to Landsat 8 OLI data, with more bands than Landsat 5 TM, 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** - your copy, not the original in L:

Switch to the Files Tab to see the Band descriptions -> click on rasters

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, so you don't need to switch them as you did for the Landsat 5 data. Clever Landsat !

Switch back to Maps tab.

Ensure you have 432 displayed and enhance - note the DN display at bottom - in 16-bit numbers
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 (= Landsat 5 TM543) enhance – note that the RGB mapper shows bands for all files loaded – this gets confusing if you load too many images.

Now 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, copy to your folder and open the panchromatic band (L: GEOG357) **pg3sept2013pan.pix**
...it will open in grayscale as it is a single band

The PAN band needs its own file, as it has higher resolution (15m); flick from this to the colour composite to see the effect of the higher resolution in terms of detail e.g. UNBC campus.

You will likely need to zoom in to see the higher resolution at work.

Viewing satellite imagery in QGIS (or ArcGIS)

Note that both GIS software can display a PCI .pix file, though if you plan to do major analysis, it's more stable to convert it to a more common format such as .img or .tif (GeoTIFF)

QGIS -> Add a raster layer and select either or both the two image files (2011 or 2013): - do what is needed to enhance – it's not as intuitive as or maybe not if you are a GIS pro ?

Also add the two vector layers

I prefer to go with QGIS as it has more RS plugins than ArcGIS – and is FREE !

Done ... and logout, it's not critical to save unless you want to re-open this image setup ('project') later with the three images without having to repeat open/enhance, then save as lab1.gpr