Remote Sensing, Fall 2023: Lab 4
Ratios, Indices, and Transforms

We'll stick with PG and Landsat 5 8-bit data bands for the first part of the lab.
Start Catalyst and open your copy of **PG14sept2011.pix** .. use the RGB Mapper to display 543 in RGB.
Questions are within the text- send text or word file to RW by Wed 11 Oct, noon.

1. Ratios

First we'll create a NIR/Red ratio CHANNEL … this can be done in three ways:

a. Tools -> Raster Calculator in Focus – we'll use this for the GIS-comfy folks
b. ARI (Image arithmetic) or c. RTR (ratio).. both in Focus 'Algorithm Library'

we'll use a. the **Tools -> Raster Calculator** dropdown

Check the file is showing: your PG 2011 file

…..we create model equations by **double-clicking** on bands, single click on operators- note that selection of a band will return %n … for example %4 for band 4
Use the Raster Calculator box for input, using the keyboard may not work the same.

To create the NIR/Red ratio: 4/3 for TM sensor (5/4 for OLI sensor)
Double-click on Band 4, single-click on / and double click on band 3
The expression should read: %4 / %3
The default is for 8-bit output = integer values only, no decimals; and output 'Display'
Change these to 32-bit real (you know why !) and 'Save' – make dang sure the File is your 2011 file, browse to it if needed. Note: we would use display only if we needed to check the result first, but you should be able to do a simple division without errors …
OK and RUN (hit the 'run' button = the wee man running)

... this creates a ratio onscreen and in the dataset which is not labelled – we need to keep a good control on what is in each channel. So change tabs from Maps to Files, and change the label to ratio 4/3 or something like that. Doing this in the Maps tab only changes the listing onscreen, and editing it in the Calculator box is ineffective
Switch back to Maps tab.

Q1a. What are the minimum and maximum DN values for the ratio ?
Check by viewing the histogram: Layer-> histogram .. click on the histogram to expand

In general the ratio should highlight vegetation (the difference between NIR and Red) and subdue topographic shading – i.e. what is similar between those bands. Check by comparing with the 543 colour composite:

'Flick between the RGB and ratio displays by turning the top layer on and off.
They are broadly similar but the ratio highlights vegetated versus non-vegetated areas, and reduces shadow areas – view the north sides of the eskers that were tough to distinguish from water before.

Unsupervised classification

Can the ratio help classification as it's a new uncorrelated layer ? Let's do a quick try:

Analysis -> Image classification -> Unsupervised classification –> you could use your previous sessions for unsupervised – add a new 8-bit layer if you need one empty

and adapt the setup, adding this new ratio channel to the inputs along with band 5-4-3, with an empty 8-bit channel as the output. OK then

Select isodata and the default parameters and OK

I think you'll find (?) there is better distinction between the water and shadows than in Lab 2 with only bands 345 as input.

2. Normalised Difference Vegetation Index - NDVI

The NDVI is the most commonly used normalised ratio (index) as an indication of vegetation biomass ….. the formula is as below:
We could use the raster calculator (RC) to create a NDVI channel:
(NIR-Red) / (NIR+Red) = (%4-%3) / (%4+%3)
you would need the brackets to get the desired result, and must use the RC keypad (not your keyboard) to enter both the bands and characters. It can be a tad cumbersome.

So instead we'll use the (newish) **VEGINDEX** tool:
Tools -> Algorithm Librarian -> use the Find box to find VEGINDEX

This seems an oddbod tool, as the Input channels seem to be a combo of TM, OLI, MSI
You will need to expand Input3 (for Red) and tick the Red band (3) and then Input5 for NIR and tick the NIR Band 4.
Output port at bottom:

use the browse button to identify your PG 2011 file, and also tick viewer

Input Params tab:
Change Sensor to Landat-5 TM
Index to Calculate : NDVI (you can view the choices, but we don't want ALL !
Output type: 32-bit real
Go to Log tab and Run (always good to see what is happening …)
Hope it works, and you'll get a new layer, already properly labelled as NDVI

Q1b. What are the MIN and Max values of the NDVI layer ?

Q2a. What is the correlation coefficient (r value) between the NIR/Red ratio and NDVI … it should be high (use the right-click on filename -> scatterplot option)

Q2b. what are the NDVI general range of values for a. coniferous forest and b. Water - flip between NDVI and 654 composite displays – you can also display the 654 composite, but highlight the NDVI in the contents, so that NDVI values show at the bottom, while viewing the colour composite …

Save the setup if you wish .. file -> save project - something like lab4-pg-ndvi.gpr ?
Enough of PG .. let's go to the **Bowron Lakes**

Copy to your geog357 folder from **L:GEOG357/bowron19aug2016.pix**
In Catalyst: file-> new project and open your copy of the Bowron file

- The date is a compromise between low snow cover and late summer shadows

NDVI
Repeat what we did in the PG scene (TM 8-bit data) with Bowron (L8 OLI 16-bit data)
Now you'll expand and click on bands 4 (Red) and 5 (NIR) – but still in "Inputs 3 and 5"
Pick your Bowron file as the Output port
Input Params: sensor = Landsat 8
Index: NDVI
Output type: 32-bit real
Go to Log tab and Run

Q3a. What is the range of values: Min and Max ?
Q3b. What ~ NDVI values are in a. Avalanche slopes (deciduous) & b. Coniferous?

3. Tasseled Cap : TASSEL

We will also run through this in lecture on Thursday.
The tasseled cap is a transformation that is often used in ecosystem and habitat studies. This operation will produce 3 new data channels equated to brightness, greenness and wetness (BGW) – it enables us to 'reduce 6 input bands' to 3 essential ingredients

Tools -> Algorithm Librarian -> Find -> Tassel

Tassel has changed dramatically recently, for both better and worse …
Input: you need to individually expand and tick the channels for B-G-R, NIR and SWIR, SWIR1 (2-7 due to the Coastal Aerosol band in channel 1). Note the algorithm refers to the two SWIR bands as SWIR and SWIR1, while NASA calls them SWIR1 and SWIR2.

Output: tick viewer-Grayscale
- and in the bottom box, save to your Bowron 2016 pix file –use the browse button*

Input Parameters
Sensor: Landsat 8
Output type: 16 bit signed (it won't run otherwise – go figure !!)
Other parameters, leave as is
Click the Log tab and Run

*I ran this many times and sometimes it wouldn't let me write to my file – if this happens to you, then untick the save to file option and just use the Viewer Grayscale display

Check the resulting 3 image channels, displayed each in grayscale

Component 1 is Brightness – an average of all the bands
Component 2 is greenness – the contrast between the visible and NIR
Component 3 is Wetness – the contrast between the SWIR and VNIR

Examine the spread of data using **layer-> histogram**, and the correlation between them (**Tools-> Scatterplot**) - they should be low correlated (Br v Gr; Br v Wet; Gr v Wet)

Q4a. What is the correlation (r) between the components:
Brightness-Greenness; Greenness-Wetness and Brightness- Wetness; ?
Q4b. The Greenness channel looks a lot like NDVI – briefly explain why.

Q5a. In the wetness channel, what features have the highest DN – higher than water !
Q5b. What type of features have the lowest DN values ? (= driest .. be specific)

4. Pansharpening

We'll run through this topic in lecture on Thursday: It visually combines multispectral information with higher panchromatic spatial resolution. There are no assignment questions here – it is more a fun exercise – and may feature on the midterm.

Copy over the PAN file to your folder from L:\GEOG357**bowron19aug2016pan.pix**
It is stored separately so that it retains its higher resolution (15m)

File-open and select the PAN file … or Layer-add – grayscale – select the Pan file
It should line up perfectly … you can't see the higher res. at full view, so zoom in on an area of interest e.g. the avalanche slopes, wetlands or glaciers. Click the top (PAN) layer on / off to see the higher resolution.

Layer – Add – RGB and add a display of the visible bands (enhance as needed)

In the tools dropdown -> Algorithm Librarian, find 'PANSHARP'
Input Multispectral Image channels –use the RGB Mapper to display bands 4,3,2

InputRef: Reference Image channels: use the same 3 bands
InputPan: Panchromatic Image channels: pick the Pan file you just copied
Tick Viewer-RGB .. we are only going to display the result, not keep as new layers

Input params: keep all defaults
Log tab: (to see what it does) and Run

The result should be 'synthetic' bands 2,3,4 – likely in the wrong RGB sequence, so use RGB Mapper to switch 234 to 432 in RGB. Click the new RGB off and on to see how it compares to the raw 432 composite pixels. Zoom in to see how it has created 4 pixels for every pixel in the original image.

It's tempting to now try this with bands 654 for higher contrast- technically a bit naughty as PAN wavelengths do not cover the NIR/SWIR bands wavelengths– but do it anyway.

Back to the PANSHARP files tab, change 234 to 456 both in the Input and InputRef options. No other changes, back to the Log tab and Run

Use RGB mapper again to ensure 654 are in RGB. Enhance and compare with the 'raw' 654 composite - tick off any layers between them in the files listing.

Some researchers classify with these higher resolution layers, but it's not standard, as the original DNs have been altered mainly for better human viewing. It can provide better classifications especially in urban areas 😊