

Remote Sensing, Fall 2022: Lab 4

Ratios, Indices, and Transforms

No more PG, we are off to McBride and Bowron Lakes

Following login, use the windows file manager to copy/paste these two image files: **mcbride15sept2014ms.pix** and **mcbride15sept2014pan.pix** from **L:/geog357** to your geog357 (labs) folder ... they are the multispectral and panchromatic image files.

In Catalyst -Focus, open your copy of the **MS image**, display 654 bands and enhance – note the ‘new’ band combo for Landsat OLI sensor - which satellite is this ?

If it's 2014 it must be Landsat 8 Thematic Mapper .. why – no others were operating, except for stripey Landsat 7 (with ETM+ sensor)

0. Checking the file

Maps v Files tabs: Maps for working, Files for Database

Check the layers you have in your .pix file – switch maps tab to files

Expand the rasters (click on +) .. check the bands / channels – no extra channels yet

Note that in the .pix data file, all pixels are 30m, so bands 8, 10 and 11 have been resampled to fit.

Band Number	μm	Resolution
1	0.433–0.453	30 m Coastal
2	0.450–0.515	30 m Blue
3	0.525–0.600	30 m Green
4	0.630–0.680	30 m Red
5	0.845–0.885	30 m Near-IR
6	1.560–1.660	30 m SWIR 1
7	2.100–2.300	30 m SWIR 2
8	0.500–0.680	15 m PAN
9	1.360–1.390	30 m Cirrus
10	10.6–11.2	100 m Thermal 1
11	11.5–12.5	100 m Thermal 2

Switch tab back to ‘maps’ when done – don’t leave it on ‘files’ while working

Add Band 1 in grayscale (layer-add-grayscale) / enhance and notice the 16 bit DNs.

Using the RGB mapper, flip through the bands in sequence (enhance each as needed)

1. Ratios

Review the histograms for bands 654 -> Right-click in the filename -> histograms

Note the contrast between the visible and IR bands

create a TM **4/3** ratio (NIR / Red) ... 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) in Focus 'Algorithm Library'

Use the **Tools -> Raster Calculator** dropdown

Check the file is showing: your McBride MS file

[.....we will 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 5, single-click on / and double click on band 4

The expression should read: %5 / %4

The default is for 8-bit output = integer values only, no decimals; and output 'Display'
RUN (hit the 'run' button = the wee man running)

... this creates a ratio onscreen .. it hasn't yet been created as a new layer in the database
But it gives you a black screen – see why by displaying the histogram for this layer –
Technically a ratio can give higher values, but often it doesn't.

Check by viewing the histogram: Layer-> histogram .. click on the histogram to expand

Now switch the output parameter from '8 bit unsigned channel' to '**32 bit real channel**'

Rerun your model (%5 / %4) -- this time the output should show a full display range as
the output values are all different - this creates decimal DNs ... move the cursor and
check some values Q1: *What are the minimum and maximum DN values ?*

RUN once again – change output to your .pix file (browse to it)

This will add a new channel (layer) to your file – it should be (new) channel 12

to properly label, switch from maps to files tab, expand rasters +, double-click on channel
12 and change it to something like ratio nir/red or 5/4 and switch back to maps tab.

Note: editing 'layer' text box when running RC, does not retain what you type (weird!)

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 Band 5 from your grayscale display done before:

‘Flick between the band 5 and ratio displays by turning the top layer on and off. They are broadly similar but the ratio highlights vegetated versus non-vegetated areas. For example, the glacier areas are now not easy to see as they are unvegetated just like bare rock. To see how the ratio DNs were created: highlight the ratio channel in the maps column but display only the 654 colour composite – you can see the ratio DNs at bottom when you click on different cover types.

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:

Use the raster calculator (RC) to create a NDVI channel: $(\text{NIR}-\text{Red}) / (\text{NIR}+\text{Red})$

Note: you need the brackets, so you get the desired result, and must use the RC keypad (not your keyboard) to enter both the bands and characters.

Output to a 32 bit channel and view - display

... what is the general range of values for deciduous (broadleaf) vegetation? - 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 composite ...

Q2a. What are the minimum and maximum DN values for the NDVI ?- note that the results are for onscreen display, so be sure 'zoom to layer' for a full image.

b. Which types of features correspond to the highest and lowest values ?

Use the (right-click) scatterplot option to see the relationship between the NIR/Red ratio and NDVI.

Q3. What is the r value and can you explain why the scatterplot line is a curve ? – this is one reason why the index is better than the ratio !

3. Pansharpening

Combining the multispectral information with the higher panchromatic spatial resolution

File-open and select the McBride 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 town of McBride or avalanche slopes or glaciers. Click the top (PAN) layer on / off to see the higher resolution. You can also compare with Band 8 in the MS file – it loses its higher resolution to match the MS pixel size.

Here we would combine them using tool 'PANSHARP' but we've mislaid the crucial metadata for this scene, so they will have to wait for a later lab. We have found a great cloud-free image of the same area in September 2022, and will do it then.

The same info is needed to run the tasseled cap and principal components analysis transformations, so we'll head over to the Bowron Lakes for the rest of the lab. And it's (briefly) back to Landsat 5 TM, 6 reflective bands (plus thermal) and only 8 bit data.

Copy this file from L:\geog357 into your geog357 folder: **bowron17aug1992.pix**

Start a clean slate – File -> new project

when prompted you can save the setup so far as e.g. lab4mcbride2014.gpr

and open the Bowron 1992 file; change display to SWIR-NIR-Red (now 5-4-3)

Note that there are only 6 bands as the Thermal has been removed.

Thus Band 7 (SWIR2) is now in channel 6 (while band 6 is on vacation!)

4. Tasseled cap : TASSEL

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 ...

The input needs to be channels 1-2-3-4-5-6, and on the first (files) tab, you need to expand each raster one at a time to click on the appropriate channel/band

I may need to show you this to see what I mean ! (this is the worse part)

Output: tick viewer-Grayscale

- and in the bottom box, save to your 1992 pix file –use the browse button

Input Parameters

Sensor: Landsat 5-TM

Output type: 16 bit signed (it won't run otherwise)
Other parameters, leave as is
Click the Log tab and Run

Check the resulting 3 image channels, displayed each in grayscale

Examine the spread of data using **layer-> histogram**, and the correlation between them
(**Tools-> Scatterplot**) - they should be mostly uncorrelated

(Br v Gr; Br v Wet; Gr v Wet ... using their respective channel numbers – 7,8,9)

Q4a. What is the correlation (r) between the Brightness and Wetness channels ?

b. In the wetness channel, what features have the highest DN – even higher than water !

What type of features have the lowest DN values ? (least moisture = driest)

5. Principal Components Analysis: PCA

Like Tassel, PCA can also reduce multiple bands to a more compact 3 channel dataset

Tools -> Algorithm Librarian -> Find -> PCA

Files tab -> tick 1-6

Output: Grayscale and save to file (= your copy of Bowron)

Input Params tab

Eigenchannels = 1,2,3,4,5,6 (6 input channels/bands)

Output = 8U

Report type = long

Report mode = log

Click log tab and Run

This generates a report file and 6 new channels: PC1-6 (in reverse display order)

Check the report box text.

The eigenvalues table gives the % scene variation explained by each channel.

Q5a: How much of the total variation from all input bands is explained by the first 2 components ??

Like Tassel, the first 3 are: brightness, greenness, wetness but it's not as clear. They are related but negatively – tassel greenness v PC2 greenness and the same for wetness.

Just as you did for the McBride image, use the Raster Calculator to generate a NIR/Red ratio, output to 32 bit real and save to your Bowron file. Now check the correlation between this channel and your Tassel GREENNESS (it used to say brightness – just use that if you already did it, but it won't be high!) –it should be high. *Q5b: What is it ?*

Email your answers as a text or word file to wheate@unbc.ca by Friday 21 October, 5pm