Remote Sensing, Fall 2024: Lab 4
Ratios, Indices, and Transforms

We'll use PG and Landsat 5 8-bit data bands for the first half of the lab, and progress to Landsat 8 16-bit data for the rest.

Notes for submitting Lab 4:

Moodle does not allow quick display for me of a text file any better than a word .doc file. But this lab has short answers which might be inserted directly into a Moodle space ? Otherwise please stick with PDF

Start Catalyst and open your copy of **PG14sept2011.pix** .. display bands 543 in RGB.

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'

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

Check the file is showing: your PG 2011 file

…..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 Landsat 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 sure the File is your 2011 file, browse to it as needed. Note: we would use just 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 [be sure to 'zoom out' to the whole layer to get a correct measure]
In general the ratio should highlight vegetation (the difference between NIR and Red) and subdue topographic shading – which 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 in Lab 2.

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 an empty one

- 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.

Use the threshold (THR) tool to create a bitmap as you did in Lab 2 (output -> viewer)

Input = the new ratio channel for this file

Minimum = 0

Maximum = 1

Q1b. How is this ratio (threshold 1.0) in 'extracting' water versus Band 4 alone ?

Does it avoid the eskers shadows, does it include any other non-water features (which) ?

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:

Method 1: Raster Calculator

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.
Output first to the viewer – grayscale; if it looks OK, run again - save to your 2011 file.

Method 2: Vegindex – check it out, but not needed if you like the Raster-Calculator
There is also 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 would 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: pick 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

Which method do you prefer ? Myself I found the vegindex confusing, with many odd indices– I don't mind typing brackets etc.. so I stuck with the Raster Calc. Either way:

Q2a. What are the MIN and Max values of the NDVI layer ?

Q2b. 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)
They must both be in your 2011 .pix file to be able to run scatterplot.

Q3. what are the NDVI general range of values for (just check a few locations)

a. *coniferous forest and b. Water*

- flip between NDVI and 654 composite displays – you could 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 …

While we're at it, let's try the NDGI (green) = (NIR-Green) / (NIR+Green)
If you are sneaky, you can avoid retyping it all in RC, just backspace over %3 (twice) in the two spots and replace with %2 (double-clicking Band 2). You can just send to the viewer and see how similar it is to NDVI – no surprise as Bands 2 and 3 are correlated.

NDGI has a lower max. value – can you appreciate why ? Think of the vegetation curve and higher reflection in green compared to red. Ask me if not sure !

We'll switch now to the **2023 image (Landsat 8)** – no need to save the 2011 setup
The 2023 image is closer to summer and has 16 bit DNs

In Catalyst: file-> new project and open your copy of the 2023 image, bands 6-5-4

Repeat the ratio in the PG scene but with this L8 OLI data
Ratio : NIR / Red (now bands 5/4)

Q4. What are the minimum and maximum values for the ratio with the 2023 data ?

You can see how the ratio has created a channel with similar values between 8-bit and 16-bit layers (2011-2023) . Let's try that threshold value of 1.0 again to 'map' water

Tools -> Algorithm Librarian .. search for THR
File = 2023 and input channel is your new ratio
Minimum 0, maximum 1
Output to viewer
It should be better due to the higher radiometric resolution of 16 bit data (more DNs)
Did it successfully isolate water ?

3. Tasseled Cap : TASSEL

We will run through this process 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 reflected 6 input bands to 3 essential ingredients

Tools -> Algorithm Librarian -> Find -> Tassel

Tassel has added many sensor options, when for years it was only for Landsat MSS / TM

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. Why can't remote sensor people just agree with each other and get along ?

Output: tick viewer-Grayscale, and viewer-RGB
- and in the bottom box, save to your 2023 pix file

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)

Q5. What is the correlation (r) between the components:
a. Brightness v Greenness; b. Greenness v Wetness and c. Brightness v Wetness; ?

Note: The Greenness channel looks a lot like NDVI or NIR /Red ratio – WHY ?

4. Pansharpening (2023 image)

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

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.

Promote (move up) as needed the 6-5-4 colour composite to below the Pan layer display

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: (you must) use the same 3 bands (4,3,2)
InputPan: Panchromatic Image channels: pick the Pan file
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 – possibly in the wrong RGB sequence, so use RGB Mapper to switch 234 to 432 in RGB as needed. 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. E.g. look at UNBC

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 / compare with the 'raw' 654 composite - tick off any layers between them in the files listing. It looks funky purple.

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 may provide better classifications especially in urban areas 😊