Remote Sensing, Fall 2018: Lab 5
Ratios, Indices, Transforms

No more PG, we are off to the Bowron Lakes
Copy the two multispectral .pix files starting with 'bow' in /home/labs/geog432/data2018
... from 2009 and 2016 (so you know which Landsats they are ...)

Start Geomatica from the Linux window
In Focus, Open your copy of the **2009 image (July 31)**, do best band combo and enhance

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0. Housekeeping

Maps v Files tabs: Maps for working (like ArcMap), Files for Database (like Catalog)
Check the layers you have in your .pix file – switch maps tab to files
Expand the rasters and bitmaps (click on +) .. check what you have
Ensure they are labelled suitably– use right-click and properties to edit their labels if not
Switch tab back to 'maps' when done – don't leave it on 'files' while working

1. Ratios and Indices

First - create a TM **4/3** ratio .. this can be done in two ways:
a. using Tools -> Raster Calculator in Focus – we'll use this
b. finding ARI (Image arithmetic) or RTR (ratio) in Focus 'Algorithm Library'

a. Ratio Channel

Find **Tools -> Raster Calculator** in Focus

Check the file: is your Bowron 2009 file

create the model, **double-clicking** on bands, single click on operators
- note that selection of a band returns %n … for example %4 for band 4
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 'Display'

%4 / %3 ... 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

Apply a linear enhancement (either use enhance icon or right-click on display name label
Now you have an image related to vegetation biomass or greenness, but it only has a few different DN values - what is the range?
(you will need to close the raster calculator to do this)

It’s hard to make out those gray levels – you can change them to colours...
Right-click on the label ‘Contents not specified’ -> Representation editor
Double-click on the colour icon under ‘style’ and create distinct colours for each DN
Apply – now you can see the pattern and how each DN ‘almost’ describes a cover type

Now switch the output parameter from '8 bit unsigned channel' to '32 bit real channel' and also we’ll save this version, so click the save button, and make sure your .pix file is selected; …. **It’s annoying that it does not assume this automatically each time !**

RUN again - close the raster calculator window - this time the output should show a full display range as the output values are all different - this creates decimal DNs ...
Check to see where this new layer is in your file… switch to ‘files’ tab and view your rasters – it should be at the bottom, and a 32-bit layer. Edit the label to something like 'ratio 4/3' and return to maps tab.

[We could also create a 8-bit full range channel by using a scalar multiplier e.g. 50]

In general the ratio should highlight vegetation (the difference between bands 4 and 3) and subdue topographic shading – what is similar between bands 4 and 3. Check by comparing with Band 4 . load Band 4 to display with:

layer -> add -> Grayscale -> next -> band4 -> finish .. (as always) enhance as needed

‘Flick between the band 4 and ratio displays by turning the top layer on and off.
They are broadly similar but the ratio highlights vegetated versus non-vegetated areas
Generally vegetated areas have a ratio DN > 1 while non-vegetated are < 1..
i.e. where near-IR is less than Visible reflection

Try a quick unsupervised classification using bands 3,4,5 as input and add a new (empty) layer in the classification session. Pick Isodata and uswe its defaults and ensure the output is going to the new empty layer. Note that it fails to separate the water and some forested areas – this is disappointing when they look quite different.

Now repeat the session, adding the ratio channel as a 4th input channel; keep the same output channel - use Isodata and defaults again. Here I was hoping it would fix the misclassified forest, but it didn't for me - disappointed again, though I'd know how to fix it - enable a lot more clusters and then merge them after, but it's too much work here.

Q1a: What is the correlation coefficient (r) between bands 3 and 4 ? (use scatterplot). \ 1b. Why are ratio values lower for Lanezi Lake (in the south - see Google maps or Openstreetmaps)

2. What are the minimum and maximum ratio values for the image (histograms - note that the results are for what is displayed onscreen, so 'zoom to layer' for a full image.

b. Normalised Difference Vegetation Index NDVI

The NDVI is the most commonly used modified ratio (index) as an indication of vegetation biomass …..the formula is as below:
Use the raster calculator to create a NDVI channel: NDVI = (TM4-TM3) / (TM4 + TM3)
Note: you likely need the brackets, so you get the desired result.

Output to a 32 bit channel and save the resulting layer to your .pix file (ALWAYS!) ... what is the general range of values for deciduous (broadleaf) vegetation? - flip between NDVI and 543 composite displays
– you can also display the 345 composite, but highlight the NDVI in the contents, so that NDVI values show at the bottom, while you are viewing the composite … try it.

Q3a.what type of land covers have values below 0 ?
Q3b. what is the maximum NDVI value and what type of land cover do they represent ?

Visit one high value area - the wee delta 'bumps' on the edge of Isaac Lake at approx: 120d52'47"W, 53d,10'22"N (use + x,y button to read lat/long) - what are these bumps ?

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2. 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

From Tools -> Algorithm Librarian -> Find -> Tassel

use these options :
Input: 1,2,3,4,5,7 (you must EXCLUDE channel 6)
Output: tick viewer-Grayscale/Viewer-RGB and save to your pix file –use browse button
Sensor: TM
SMOD: AUTO
Click the Log tab and then Run

Check the resulting 3 image channels (Brightness, Greenness, Wetness – BGW), display each in grayscale and the composite - it has high contrast, but the colours are tough to interpret ...it might be easier if you reverse the channels using the RGB Mapper (try BGW -> BGR instead of RGB).

Examine the spread of data using **layer-> histogram**, and the correlation between them (**Tools-> Scatterplot**) - they should be uncorrelated (view B v G; B v W; G v W … using their respective channel numbers)

Check also the correlation between **greenness and NDVI** (it should be high- why ?)

Q4. What are the r values between:
a. Brightness and Greenness, *b. Greeness / NDVI ?*

Run an **unsupervised classification** using only the 3 TASSEL channels as input with K-means or Isodata and 16 classes .. use an empty channel for output (create it if needed) ... is the classification output better than we did using bands 3-4-5 ? In theory it could work better as the channels are 'more different' from each other = less correlated.
But again ... the result is likely to be much the same as before – this is bugging me!

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3. Landsat 8 scene: 19 August 2016

- Open the 2016 image - remember the data are 16 bit and an extra band 1, which 'pushes down' all the other bands.

- Flick between 2009 and 2016 .. 8bit vs 16bit data, but also the 2016 image is almost 3 weeks later in the year so a. shadows are longer and b. vegetation is more 'advanced' towards senescence. Thus expect NDVI values to be lower.

- Create NDVI using the Raster Calculator and save the output into a 32 bit channel; get the right bands and be sure to label the new channel (NDVI).

Q5a: what are the minimum and maximum NDVI values for 2016 ?
Q5b. How much has the value decreased from 2009 for the Lake Isaac shoreline deltas?

- We could run TASSEL on the Landsat 8 data, but we'd need to cheat and use the Landsat 5 TM parameters. Not worth doing just now. But we'll use PCA instead.

Principal Components Analysis: PCA

Using the PCA tool, click on all bands 1-7 as input – be sure it is the 2016 image
Parameters: eigenvalue channel numbers = 1,2,3,4,5,6,7
-This is the maximum possible, 7 new channels from 7 inputs
Output- Viewer grayscale
Parameters
Output raster type = 16U (same as input channels)
Report = Long
Run .. and view report box. The eigenchannel table shows that the first 3 channels 'explain' or contain 99% of the overall scene variance. In the eigenvector matrix table below it, the number show that the first row (channel) is positively loaded by all input bands, while the 2nd row (channel) matches a positive 'loading' for the NIR band 5 versus negative values for the visible bands – this is the closest output channel to 'greenness'

Send me the answers to Q1-7 by Tuesday.

- **Possibly next week we can solve the water vs forest issue**