Lab 9: Image fusion and Glacier extraction

This lab uses a Landsat 8 OLI image (Path 48 Row 22) from Monkman Park, ~100km NE from PG: the glaciers in the park are geographically the closest to PG - Monkman/Parsnip in the west, Ice Mountain in the south and Limestone/Weaver mountains east of there. The MS file contains bands 1-7 along with band 9 (Cirrus) in channel 8. The PAN (chromatic) band remains as a separate pix file because if we included it in the multispectral file, it would lose its higher resolution (15m).

We will first 'fuse' your OLI high resolution (15m) PAN band with three selected RGB multispectral bands (30m), and view the results, to use for checking derived vectors. Then we will use the OLI (30m) image to extract glacier extents for 3 September 2013. These steps will set the final lab assignment questions

General repeat notes:
a. The DN value display below the image relates to the highlighted layer, not necessarily the top layer, nor even one being displayed. This can be useful as e.g. you could display the colour composite but query ratio values etc..
b. The maps tab relates to display; the files tab relates to the database. e.g. for details on displayed layers, you use the maps tab; to create a new layer, use files tab.
c. After loading a new layer, you should always enhance as needed (DUH!)
d. Add all new layers to your monkmanpan .pix file

Copy **L:/labs/geog432/data2018/monkman2013.pix** and **monkmanpan.pix .....** into your geog432 folder

Start Geomatica2017; open your copy of the two files (they are 'clipped to fit' !)

0. Labelling the layers

The band labels include the download details, and conceal the band descriptors at the end. You should shorten their names so you can quickly see which band is which, if not already memorised (they might be if we had used Landsat 8 all term). You don't need the path/row and dates on each band, just the band descriptors.

Flip the 'tab' to files (from maps), expand 'Rasters' and edit the labels for the multispectral layers to concisely reflect what they are ..
You should maintain this practice of labeling layers, especially creating new ones.

1. Pansharpening ('Fusion')

First (AS ALWAYS), switch the bands so you are viewing a normal colour composite with red, green, blue (should be 432) in the RGB guns (not 234), and enhance.

Also open the high res PAN .pix for the same area, and compare – zoom in (a lot) on a glacier edge and note the higher detail / resolution

… check the number of pixels of the PAN file - it has twice as many in x and y as the main file (files tab, right-click -> projection)

In tools -> algorithm librarian find the **PANSHARP2** task
(there is PANSHARP also, but it does not seem to work as well)

Input multispectral channels: 432 bands (in the correct order, one at a time)
InputRef: leave these blank
InputPan: Panchromatic Image : Tick the Pan Band file
Output: Viewer-RGB AND write to the PAN band pix file (we want 15m pixels)

Parameter: Enhanced Pansharpening: YES
Run

As usual, enhance as needed
From a distance it will look the same as the 432 composite, but when you zoom in you should see a less pixelated image. This image will be useful to check the glacier outlines and to see more details in the shadows.

Glacier extent extraction

Data display

Layer-add and add another RGB for bands 654 - compare the details visible in shadowed areas versus the 432 and pan sharpened combinations – especially look for glaciers/snow in the shadows and compare the three RGB displays.
Note that this is a decent late summer image but with remnant snow outside the glaciers - the same spectrally as snow on glaciers, and will need your sieving skills to remove
Also load the 1985 glacier extents - vector (shapefiles subfolder): monkman1985.shp

2. Create a Red/Mid-IR ratio (OLI 4/6)

Transfer band 6 (mid-IR) into the PAN file
With Landsat 5, we would use bands 3 and 5; with Landsat 8, we can be sneaky and use the PAN band (15m pixels) to substitute for the Red with finer (15m) pixels but the MIR band MUST be in the same .pix file, so transfer Band 6 into the PAN file:

File -> utility -> transfer
source: monkman2013.pix
destination: monkmanpan.pix
select only band 6 .. add and transfer
The band will be added to the higher resolution file and resample into15m pixels

Now you are ready to create a ratio using the higher resolution to give more detail

Tools-> Raster calculator .... you know how to do a ratio - make it so.

Ensure you are working on the PAN pix file (15m)
Pan band / mid-IR
Ensure that the output is going to a 32 bit channel
Output: Display and Save to the Pan file
….. and run
Close RC

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3. Thresholding snow and ice

Click around the ice surfaces to see possible threshold values, especially the darker ice near the snouts. To compare with the 654 display, highlight the ratio channel, but check it off, and view the 654 RGB; click around to review ratio values on the darker ice areas. For TM data, we would normally use 2.0 as a threshold to identify snow and ice, but here with OLI data, 2.0 captures most ice and snow but not all the darker ice near the snouts. I found somewhere in 1.3 to 1.5 to be more inclusive – otherwise we lose some snouts..

The exact value is always a toss-up between getting all the ice but including some non-ice. Make your own judgement - there may not be a perfect value, and there's always possible sieving and editing afterwards.

We can either use THR to generate an ice bitmap or EASI modelling to create an ice channel. I find the easiest way is to use THR and then convert the bitmap into a channel which can be sieved:

THR
We want to send all pixels with ratio channel DN > ~1.4 or 1.5 to display (bitmap)
Input = the ratio channel
parameters - minimum threshold = choose your value
no value needed for maximum
Run

Check display - too much, too little or good enough ?
Try at least two different values and settle on a best option
Then run THR again and save to your PAN file

Add an empty 8-bit raster channel: files tab->right-click on the file and new-> raster layer

In EASI modelling convert the ice bitmap to a raster layer:
%x = %%y (x and y are the appropriate new empty channel and ice bitmap numbers)
- if you actually type 'x' and 'y', yell loudly: "DOH .. I am a total doorknob"
- check that your new channel contains the ice info: layer->add->pseudocolor
It should have many small areas due to the nature of pixelation plus there are small remnant snow pockets, and we only want the ‘real’ glaciers which exceed a given size.

Check the layer by clicking on and off with the 654 (30m) composite – and then for shadow areas view the 432 (15m) composite.

Assuming it looks good, you can proceed to sieve it

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4. SIEVE

Find sieve in the alg.lib and use the new threshold channel as input
Sometimes we use 1 hectare as a minimum size, but I know it's too small, and even 2 ha, so let's go 5 ha = 56 pixels (1 pixel =900sq m.; 5 ha =50,000 sq.m. = 55.55 pixels)
I might also consider 10ha = 111 pixels ...
If it seems you are losing small bare rock areas, inside the glaciers (nunataks), you can specify 0 in the Exclude Values list parameter in SIEVE

Try 56 as the threshold and 4 for connectness
Output first just to display – RUN, and view … the goal is to eliminate snow patches but not significant glaciers. If there are still many 'fake' glaciers, consider a 111 minimum

run one final time with selected threshold, and save it to your PAN file.

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5. Conversion to raster: RAS2POLY / smoothing

Same as last two weeks, run RAS2POLY - you can use the auto smoothing option
- or if you wish, or also use SMMCMASTER
I find that is smoother and the lines are more natural, but there are some later issues with the smmcmaster process, and resulting polygon lines (which can be easily edited).

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6. Vector clean-up

The process should generate glacier polygons and in addition bare rock areas inside the glaciers (nunataks) are recorded as polygons but with pixel value = 0.

To remove an unwanted external polygon - if it's there, its the first entry and much bigger than the others, right-click on the top row and delete (ensure only the top row is selected)

To remove the area of nunataks in the glacier area calculations, Right-click the vector layer in the contents, and view the attribute manager:
Select: Record -> query by -> example
Select pixel value = 0 (remove the 'AND' in the statement)
then tap the Insert key, then OK
In the left column, right-click on any one of the selected records and delete
Layer -> save then Close

Now also save as a shapefile:
Right-click on the vector label in maps tab
Save as Arcview Shapefile (with a suitable name e.g. glaciers2013.shp)

Questions: 5%

General interest: In the SW corner are two lakes: Arctic Lake to the northwest and Pacific Lake(s) to the southeast, the latter divided by two alluvial fans. These form the Arctic-Pacific Lakes Provincial Park. One lake outlet flows northwest to the Williston / Arctic and the other southeast to the Fraser River / Pacific. Check it out on Google maps.

1. Compare the two SWIR (Mid-IR) bands in the 30m MS .pix file

a. what is the correlation coefficient between the two bands ?

b. Describe the differences between the two bands by viewing them and their histograms. You can't see much viewing them separately as gray tone, so view them together by adding a RGB layer and loading one in R, and the other in G and B. Where are they similar (DN values) and where are they different ?

2. Create an NDVI (32 bit) layer - rank these land cover types by their DNs - lowest first

Bare rock, coniferous, lakes deciduous, glaciers

3. From your 'clean' smoothed version of the glacier area vectors ..

a. what is the total area of glaciers (2013) in km^2 (2 decimal places)

b. what is the % area loss since 1985 ?

4. Lastly, examine your glacier outlines and evaluate how they are: identify any types of mis-identified ‘problem’ areas which you can now see are likely not snow/ice – and also any types of ice/snow areas that are not captured by your threshold value. Equally you can praise or critique the qualities of your vectors, and their smoothness or realism. Use the pansharpened image as background to check the quality.

5. Please also include your final glacier shapefile, by emailing it to me as .zip remember this requires more than one file - a minimum of 4 (shp, shx, dbf, prj).