Lab 7: Glacier extraction

1. Introduction

This lab uses the Landsat 8 OLI 2015 image of the 'Resthaven Icefield' (rh) from the Willmore Wilderness, AB. The file contains bands 1-7 plus band 9 (Cirrus) in channel 8. The PAN (chromatic) band 8 remains as a separate pix file because if we included it in the multispectral file, it would lose its higher resolution (15m).

This version of the lab is simpler than that tried in the lab this week as we had some issues with some operations: I've removed the 'EASI-Modelling section.

In windows explorer, copy to your own folder, these files from *L:/geog357/*
rh2015.pix
rh2015pan.pix
rh2015thermal.pix

2.Data display

Load rh2015.pix and display the 432 composite – some clouds are apparent
For interest, let's see what is in the Cirrus band (band 9=channel 8)
Layer-add-grayscale – channel 8
You can see the high clouds plus some background imagery
click the grayscale layer off

Add another colour display: layer-> add-> RGB to show the 654 composite (enhance) - … the clouds seem to be less intrusive
this demonstrates the IR bands ability to penetrate haze and 'some' light clouds

Compare the 654, 432 and Pan displays in the glacier areas
– especially look for glaciers/snow in the shadows and compare the RGB displays.
Note that this is a good late summer image with little remnant snow outside the glaciers – which look the same spectrally as snow on glaciers.

We can load the thermal band to see if it helps
file-> open .. select thermal2015.pix (enhance as needed) ..
it's lower spatial resolution..(100m) and certainly picks out the ice versus the two fires;
click between the thermal band and 654 composite to see how they relate to each other.
Change the thermal display to the 2nd band (TIRS bands 10 v 11) – it is not too different
In both cases, cooler brightness temperatures correspond to both glaciers and shadows
Click off the thermal bands

3. Glacier extent extraction

a. Unsupervised classification

Run a quick Isodata classification (analysis->Image classification) – input bands 4,5,6 and use the default values – 16 classes; you will need to add a new empty 16 bit layer to hold the classification

You will likely find it can't distinguish shadows from other features and does not isolate glaciers sufficiently into clusters. Could you group several clusters to extract glaciers – maybe, but it's not a tidy method.

b. NDSI

Use the raster calculator (RC) to create NDSI: (Green – SWIR) / (Green +SWIR)
remember to single click on operators and double-click on bands selected
Output to 32-bit layer (display) .. and save to your Resthaven (rh) file

Glaciers have the highest values for clean snow and ice, but can't always isolate these three problematic features: Shadows, water and debris-cover. What seems to be a good lower threshold value for snow/ice ? (and excluding most water).

View the histogram for NDSI and see what DN might separate the two peaks in the curve (land / ice). Run THR with your best guess (minimum) threshold value

Q3a. what is your chosen NDSI threshold value for snow/ice ?
3b. If you reduce it slightly, which other land cover types does it start to include ?

c. Create a Red/SWIR ratio

Use the Raster Calculator to create the Red/SWIR ratio (4/6)
Output to a 32-bit layer and save to your multispectral .pix file (ALWAYS!)

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

Edit the description for the new layer/channel to: something like Red/SWIR ratio
Review the histogram for the new channel – a threshold value should be somewhere in the dip between the two peaks.

4. 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 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.
It could be more like 1-7 or 1.8 – otherwise we lose some glacier snouts..

The exact value is always a toss-up between getting all the ice but include 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 first use THR to review an ice bitmap, as we've done before for water

THR

We want to send all pixels with ratio channel DN e.g. > ~1.75 to display (bitmap)
Input = the ratio channel
parameters - minimum threshold = choose your value (maybe 1.65-1.8 ?)
no value needed for maximum
Run

Check display - too much, too little or good enough ?

- Compare with 654 composite by clicking bitmap on and off

Try different values and settle on your best option
Then run THR again and save to your rh2015.pix file

We could then run BIT2POLY as we did in earlier labs, to create glacier vectors.

Though, There are two issues with the bitmap approach:

a. . There are isolated pixels, and small groups – and you can't sieve a bitmap

b. The threshold fails to find glaciers in shadow as the ratio DN is lower, but does find (silty) water which has higher DNs. Flip between the 654 composite and pansharpened image to better see the glaciers in shadows; in comparison, they are hard to see in the IR.
See also where the threshold has included silty lakes. e.g. 329000E, 5925000N
Debris covered ice: we can't do much about this – it's an advanced research topic.
e.g. there's debris-covered ice ~ 340000E, 5922500N and also 3337000E, 5930000N

For now, we'll just solve a. by using the tool EXPOLRAS

5. Conversion to vector: EXPOLRAS

We used this in the Feature Extraction Lab
Input file will be your new channel containing only glaciers (12 ?)
Output to your rh2015.pix file

The threshold minimum would be the value you determined in 4. above
The minimum area parameter would be 11 for a hectare standard or 22 for 2 ha.
In glacier mapping, we often use 5 hectares as a minimum = 55 pixels.
Set your threshold minimum area to 55 (pixels)
run .. if the result looks good, you are ready to smooth

Now smooth these vectors as you did in Lab 5 using **SMBOYLE** in the alg.lib

Input = the vector layer just created in EXPOLRAS

(and always write the result to your .pix file)

6. Vector attribute table

From the attribute manager,
Q2a. What is the sum total area (km^2) of glaciers in 2015 ?
Check the section in Lab 5 if you forget how to do this
You can also save as a shapefile: - Right-click on the vector label in maps tab-> Save as -> Arcview Shapefile e.g. rh-glaciers2015.shp

Use a screen capture to show your result:
With your choice of a suitable background image: e.g. 654, 432, or PAN,
Zoom to the glacier area so it is all visible
Add your final glacier vectors, if they are not on screen
ensure colour for your 2015 glacier outlines for best contrast (red or yellow?)

On your keyboard, Select PrtSc button - The screen image will turn gray
Draw a 'clipping box' around the area you want using the cross-hair
Grab the main glacier area – outlying small (errant?) vectors are optional
Open Paint (or some other graphic package) and pick 'paste'
Save as .jpg

Q3. Include this jpg with your answers for next week. There will be questions to add in Lab 8. Hold your answers till next week ….
I suggest you create a word document with both the text answers and .jpg embedded inside rather than a separate doc and .jpg

7. Using the higher resolution PAN band ('Optional')

As described in lecture, some like to use the Pan band on Landsat 8/9 instead of the Red band to create the ratio layer with 15m resolution.

First you will need to add the NIR (5) and SWIR band (6) to the pan file (not vice versa)

File-> Utilities-> Transfer layers…

In the pop-up window, source file = rh2015.pix

Destination file: rh2015pan.pix

Highlight bands 5 and 6, then click add , then 'transfer layers' and close

Display your transferred SWIR layer in the pan file to check it worked:
Layer-add-grayscale .. and pick the SWIR layer in the PAN file
The SWIR band now has the same resolution now as the PAN band, but looks blockier as you can't just add detail by duplicating pixels, … this will happen with the new ratio:

Repeat steps 3c-7 but using the PAN band instead of Red

3c: Pan / SWIR ratio – using the rh2015pan .pix file

4. Thresholding the ratio – use the ratio in the pan file

6. Conversion to vector – EXPOLRAS - again all in the pan file

7. Vector attributes – revised glacier area using the higher resolution

.. your ratio and threshold values in 4 may be different to before with Red/SWIR, you will need to find this new value to create the best glacier outlines

However the NIR value (8000?) will stay the same. [we had to include the NIR band in the transfer so you can include the silty water factor in step 5].

Q. What is your glacier area estimate using this method – it should be close to your previous answer in section 7