GEOG 357, Fall 2023:
Lab 8 CHANGE DETECTION

1.Introduction and goals

We will look at 'change' comparing image data for part of Willmore Wilderness Area – that is what I entered to access the scenes for Path 46, row 23, and then subset the images.

The images are as follows:
1. August 10 1986 Landsat 5 TM
2. August 8 2008 Landsat 5 TM
so these are almost 'anniversary dates' with similar snow patches.

3. August 26 2015 Landsat 8 OLI
4. September 9 2023 Landsat 9 OLI2
these two later dates involves longer shadows but fewer remnant snow patches, so they could be superior for glaciers but also have late summer vegetation (= declining NDVI values).

The goal of the lab is to enhance and capture 'actual' change (in the DNs) from 1986-2023.
The biggest events were two major wildfires in 2007 and 2015.

2. Viewing the images and changes 1986-2023

Copy these .pix files to your labs folder from *L:/GEOG357/willmore*
resthaven1986.pix
resthaven2008.pix
(rh2015.pix) – you should have this from last week
rh2023.pix

Start Catalyst → Focus

Open the image files for 1986, 2008, 2015, 2023 (your folder)
change to the optimal combination for each (SWIR /near-IR/Red) 543 (TM) or 654 (OLI);
enhance -- and try to get equal stretch/contrast on each image – note that you need to highlight each file in turn to enhance that image.
click off the top one, then the second one to see each in turn, and the changes.

Features: Resthaven Icefield, Ptarmigan Lake (top), Twintree Lake (SE corner),
Jackpine River (top) and Smokey River (running south-north on the east side)

The most obvious changes are the two big fires in Jackpine River valley (2007) and Smokey River (2015) … for location, if you continue up the Smoky River valley, you end up crossing the border into Mt. Robson Park just above Berg Lake. The fire effect is way more imposing than if you view it in 'natural colour' on google earth timelapse. There is also glacier loss 1986-2023.

Here's a question for you (Q1 and 2 were from last week – repeated below)
Q3. Explain the changes in the Digital Numbers within the two fires for the 3 bands shown i.e. whether red, near-IR, SWIR decreased or increased between the 2 pairs of dates and why.

a. *1986-2008 (8 bit DN values)*
b. *2015-2023 (16 bit DN values)*

Previous questions (from Lab 7)
Q1a. what was your chosen NDSI threshold value for snow/ice ?
1b. If you reduce it slightly, which other land cover types does it start to include ?

Q2a. What is the sum total area (km^2) of glaciers in 2015 ?
Q2b. Include this jpg showing the glacier outline

Don't use the colour guns RGB to explain e.g. Green went up, although you may in conclusion say 'this is why it appears' this way on the image.

Do this by examining DN values inside and just outside the fire area for similar forest or by comparing the two Landsat 5 images, as the DNs all change in 2015 with 16-bit data.
You can't easily compare 8 bit and 16 bit data values ..

You should be able to see these changes:
the fires of course
some changes in the Smokey River including some new wetlands ~352000, 5917000?

a new landslide 1986-2008 just south of Jackpine River (~ 334100, 5937000) blocking/creating a small lake (~333000, 5936400) – find it by using the 'cursor control' (+x,y icon – top row)

and another looks like a new lake ~331500, 5918400 but it's a shadow –see the cloud (to the SE) …. there is no change on bare rock slopes

Another change is the vegetation seems to be advancing up the alpine slopes thru time

Finally there is evidence of glacier retreat, with less seasonal snow in 2015, as it is two weeks later in the year. Zoom in on the glaciers to see some definite retreat and also new meltwater lakes where there used to be ice.

3. Simultaneous display

Now display the equivalent bands from each date simultaneously: **layer-> add -> RGB**
Start with band 4 – for 1986, 2008 and 2015 to contrast the fires .. 2023 should only show subsequent regrowth / green-up

Band 4 (1986) in Red and band 14 (2008) in Green and Band 5 (2015) in Blue-
You'll need to select the file and band each time … Enhance as needed

an increase in DN (vegetation health) over the (~30) years will show as red, and no change as gray shade; decreases will show in blue/green

Now use the RGB Mapper to switch these 3 to the SWIR1 band for each image (enhance) .. this may be more illustrative as glaciers will be black (no SWIR reflection). Increased SWIR reflection = increasing dryness (less trees, less water/ice). This should pick out both the fires and glacier change … and also changing shadows (longer in 2015).

As commented in class, it is tricky working with individual bands – especially with a mix of 8 and 16 bit data, so the next section will involve image subtraction using two indices: NDVI and NBR (burn ratio).

I found that the Raster Calculator and new channel creation was acting up recently, so I did some work for you and have prepared a pix file containing the four NDVI layers, and another with burn ratios and delta burn ratios (the change between two burn ratios):

4. Image differencing

Copy over these two files from L:GEOG357\willmore to your own folder:
rh-ndvi.pix
rh-burns.pix

Open the ndvi file – they are in chronological order, so open with the first 3 dates in RGB. The small landslide that first appeared in the 2008 image should show up in 'pure red'.

Q4a. Explain why it displays as mostly red (=the same as why it has those NDVI DN values)

4b. What is the approx. mean NDVI value for the two Landsat 5 images and for the two Later images (2015/2023). Two decimal places are enough.

Add the rh-burns file .. the dBNR (difference) will be displayed in the Blue Gun.

It might be easier to view just the difference layer – add it as a grayscale display
Querying the decimal DN values should be highest for the Smokey River fire (2015).

DBNR values > +0.66 are considered to be 'high severity' (see link below)

https://www.earthdatascience.org/courses/earth-analytics/multispectral-remote-sensing-modis/normalized-burn-index-dNBR/

Use the THR tool (threshold) to display onscreen all pixels > 0.66 DN

Q5a. Where in the 2015 fire are the highest severity DN values ? (describe by relative location)

5b. Other geographic features, which weren't burned also share high values – what types of features are these and can you explain why they have these high values (think about how the NBR is created.

Note if we were trying to extract the burn area, we would mask out or sieve other areas.

Please send your answers (5 questions) to wheate@unbc.ca
A word file or pdf would be easiest … send by Wednesday 8 November

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Image cross-classification – for reference only

You can also classify each 3+ band image, and compare the classifications -

You would need to train areas and do a supervised classification for this area, apply the training areas to each image (bands 5,4,3) data, using similar training areas.

We can also re-classify areas that have stayed the same, and those that have changed e.g.
1 Water 2 Deciduous 3 Coniferous 4 Cutblocks 5 Bare rock ...
We would look at only the classes that we think may have changed (or the matrix is huge)

under multi-layer modelling, select **MAT (matrix analysis)**
Input channels will be your two classifications
Output channel = any channel you don't need
MRV1 and MRV2 - for the example above, these would be 3,4,5