Remote sensing, Fall 2018:
Lab 8 CHANGE DETECTION

Introduction and goals

We will look at 'change' comparing image data for Bowron Lakes (Path 47/Row 23).
The images are August 2, 1998 and July 31, 2009, so they are almost 'anniversary dates' but the 2009 image has higher remnant snow cover resulting either from heavier snowfall in winter 2009 or slower melting in summer 2009; the snow cover difference is not significant in this lab.

The goal of the lab is to enhance and capture 'actual' change (in the DNs) from 1998-2009. e.g. new cutblocks, forest health, regrowth, vegetation loss through mountain events. The two images match well in illumination, but the changes are not huge as much of it is a provincial park.

1. Setup

Data organisation will be key in this lab; All layers created will be stored in the same PIX file
by the end we will have have one big new file that holds all data ....

Start Geomatica and use file->utility-> transfer option to transfer all layers (7 TM bands) from
L:\labs\geog432\data2018\bow2aug1998.pix (= source file)
..into the clipped 2009 pix file you have used in recent labs (6 and 7) = destination file;
the 1998 image has been clipped to match the extents for the 2009 image.
Note: do NOT use the pix file from earlier labs as it was slightly larger in extent

2. Display colour composites for 1998 and 2009

Open your 2009 pix file and display the 543 composite for 2009
Check your raster layers for the 1998 bands – they will be 7 bands labelled 'transferred from ….' ;
you could relabel them 1998 band 1, band 2 etc… or maybe it's already obvious what they are ..
layer-add - RGB to also display the 1998 543 colour composite and enhance to match 2009

Also add the Bowron Lakes park boundary (vector): layer-Add-Vector .. and select bowron-utm.shp
in the … */home/labs/geog432/data2018/shapefiles* folder
 - remember to click on the 'available vector segment' window as well as the filename

- click the top listed composite on and off to see the changes between the dates

The changes are not huge, especially inside the park: aside from the snow, the main ones are:
   a. New cutblocks and some regeneration, mostly west of the park
   b. Colour changes in the coniferous forest – result of Mountain pine beetles ?

c. Apparent devegetation of the slope south of Kaza Mountain (see google maps for location – though it seems the Google Maps image does not include this effect). There are two smaller similar effects (redder in 2009) towards the top of Isaac Lake ~634350, 5903100 (just inside the park) and ~ 632000, 5899500. Rockslides ?

Question: what is causing the main difference in colours - which bands have higher DNs and why? (check the cursor DN display at the bottom) .... query a location and then switch between the colour composites in the 'maps' contents (you don't need to change the display).

Check the overall histograms for bands 3-4-5 (**layer-> histogram**). Ideally for unbiased change detection project, the histogram for each band across the years should be similar - only details have changed, unless there was widespread change, e.g. massive beetle kill.

The 2009 image, has higher overall DNs than for 1998, notably for the RGB visible bands. This is likely a result of the difference in snow cover.
Mean/median DNs and standard deviations (sd) are listed below:

Band	1998	sd	2009	sd
1	52	18	59	27
2	23	11	26	18
3	19	14	23	22
4	53	23	56	25
5	46	26	46	24
6	128	8	133	8
7	18	13	19	12

This confirms that the IR bands with similar means/sd between years will be more useful than the visible bands where means are slightly higher and sd values are much higher for 2009

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3. Simultaneous display

Now display the equivalent bands from each date simultaneously: **layer-> add -> RGB**
Start with band 1 (2009) in Red and band 1 (1998) in Green and Blue- Enhance as needed

With 2009 in red, and 1998 in blue/green, an increase in DN over the 11 years shows as red. Probably there is not much useful information in the visible bands comparison.

For subsequent band comparisons, rather than adding yet another RGB display layer, instead just modify the last one - right-click -> RGB Mapper and change the bands1 display comparison to bands2 then bands 3 etc.. until you've tried them all.
It will be more interesting / clear in the IR bands

Note the areas that are most 'red' (DN increased) or most 'blue-green' (DN decreased)
For each one, click around the image and see the magnitude of the changes (= the difference between the two DN values)- **remember to have active the display you are looking at** (select/highlight it in the 'maps' tab on left)
If the DN difference > a user specified threshold, then we can extract it!!

Q: Which band comparison seems to show the changes best ? [For me, it was band 5]
Can you identify a 'threshold' difference - by querying the DNs in the red-blue/green composite and viewing the DNs at bottom ?

... above that number could be real change - one of the areas you viewed above as a new cutblock or 'rockslide' etc.. while below that number a difference is not meaningful

Usually with clearance, the DN has increased (except for band 4), but there could also be differences the other way, where DNs are lower in 2009 e.g. in regenerated cutblocks.

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4. Image differencing

In 3. above, we used display to view potential change; now we will create a new difference channel
We can perhaps assume that we are most interested in the positive changes (increase in DN).
Note: I always hope this will be impressive, but the results are disappointingly itty-bitty

Step 1: Using Raster Calculator (RC) to subtract

Tools -> Raster Calculator

Subtract Band 5 (2009) minus band 5 (1998)
Set output to display, and 8 bit unsigned channel
Close RC and query the DNs in areas of real change - does this capture the change ?
Overall I found band 5 to be the clearest (feel free to try another)

Run your best result (band 5) and set output to your **2009 file** - remember to tick this option and pick the file from browse - it seems the useful differences are all positive, so the output can be the default unsigned 8 bit channel
then RUN (it will create a new channel in your file)

Will you remember what this new channel is ? .... best to relabel it:
switch to the 'files' tab, right-click -> properties and edit the text to ~ band5diff 2009-1998

Step 2: creating a threshold bitmap THR

Determine a numeric threshold for a meaningful difference (20-25 ?)
What is the threshold DN that separates 'real change' from chance variation ?
Query the difference channel to find the range of values in areas of change and mentally
select the approx minimum DN - but be prepared to raise the number if that captures too
many non-change pixels or lower it if change areas look ragged

In the algorithm librarian, select THR
In parameters, assign the threshold maximum
Display just to viewer ... Run
Lower the number if areas look ragged, raise the number if too many extra pixels - but
remember we can sieve later; try a few different DNs till satisfied

When you have found a good compromise, Run again and write output to your file

Step 3: convert to a raster layer and run SIEVE

Remember from before, that you can't apply SIEVE to a bitmap, but we can convert bitmap
to raster in several ways - the quickest is as below:

ensure you have an empty raster, if not create one ..
files tab -> right-click->new->raster layer (8 bit)

In Tools-> EASI Modelling type:
%x = %%y   (where x = the empty channel number and y=the bitmap number)
!!!!!!! DO NOT TYPE x and y !!!!!!
Run ... and now you have a channel for sieving
To display it, layer-> add-> **pseudocolor** (NOT grayscale)
Why? – because it contains only DN 0 and 1 which you can't see on grayscale

SIEVE
Input is the channel you just created and 'filled' from a bitmap
I suggest you use a 4 ha minimum = 45 pixels
Save to your pix file

Step 4: use task RAS2POLY to convert raster outlines to vector polygons
Check (tick / accept) the default smoothing and save to your 2009 file (ALWAYS!)
display new change vectors on top of 2009 colour composite 543

In theory, we might get better results using an index .... but not this day !

This page for reference only

Running Tassel, Ratios or Indices to generate new channels

An issue with the simple band arithmetic above, is wondering which band to choose. This may be easier if we use new components that incorporate elements of all channels, such as TASSEL or ratios. However I have tried it and in this case the results were disappointing , so I won't ask you to run TASSEL again. This might work better in a non-park environment.

We would do the same as above but subtracting the difference between NDVI DNs or TASSEL greenness.

Image cross-classification

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
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