

Remote sensing, Fall 2016: Lab 8 CHANGE DETECTION

Introduction and goals

We will look at 'change' comparing 1992, 2009 and 2011 image data for Prince George (Path 48/Row 22).

The images are August 4 1992, August 8 2009 and Sept 14 2011, so there are three possible types of change:

- a. Actual change over these years, e.g. new cutblocks, fields, insect infestations
- b. Seasonal phenology - e.g. fall could be more advanced regardless of the date
- c. Weather: Haze, clouds and cloud shadows

The goal of the lab is to enhance and capture 'actual' change (in the DNs).

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 one big new file that holds all data layers

Important points to remember:

- || When you view pixel DN values, they refer to the layer highlighted in the 'maps' tab, NOT whichever is the top layer ... the layer it refers to might not even be visible (ticked 'on')
- || Always enhance (linear or root) when loading/viewing a new layer
- || ALWAYS save to your PIX file - most operations requires layers being in the same file

Copy this file to your folder **/home/labs/geog432/data2016/pg1992to2007.pix**
rename your copy something like: pg920911.pix or maybe just something like **pglab8.pix**
(... there is no 2007 scene, I mistyped it- this new file will hold data for all 3 years)

Start Geomatica and open **pglab8.pix** (or whatever you called it)

Transfer the (7) TM bands from your copy of pg14sept2011.pix into this new file ... you should now see 21 raster bands in the file - 7 each for 1992, 2009 and 2011. Wave a hand if you don't.

Note that 1992 bands are now in channels 1-7, 2009 are in 8-14 (mislabelled however – fix it) and 2011 are in channels 15-21.

Note that this lab is a tad experimental - Roger spent a long time trying to find comparable images and achieve a stunning result, but only with sparse success. You may do much better in a project - you might even pick something like your environmental change assignment images.

2. Display colour composites for 1992, 2009 and 2011

- switch the display to 3-2-1 (RGB) for 1992; enhance
- layer -> add -> RGB and pick channels 10-9-8 to display the 2009 composite; enhance
- repeat and pick channels 17-16-15 for the 2011 composite; enhance
- click the top listed composite (2011) on and off to see the changes since 2009
- do the same to compare 1992 and 2009; 1992 and 2011;
- switch all 3 displays to 5-4-3 composites for comparison - enhance so that they match in colour contrast, and flick-click to view the changes

You will note some obvious changes among other things:

- a. New cutblocks and some regeneration
- b. UNBC - built, and sports centre and new road
- c. Mountain Pine Beetle impact
- d. Ladies soccer field (15th avenue below University hill)
- e. Fraser River - perhaps different water levels and siltation
- f. small changes to the lakeshore of Tabor Lake
- g. Golf courses - building of Aberdeen and site of (failed) PG golf club
- h. Greening of plantations in Forests for the World

Question: what is causing the difference in colours - which bands have higher DNs and why? (check the cursor panel) 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.

In fact the 2011 image has lower DNs due to the later date; 1992 and 2009 are close, but 2009 slightly lower except for band 4 and 6. Perhaps the slightly later date for 2009, and lower sun is still compensated in Band 4 with continuing plant growth and vigour ? Mean DNs are listed below:

Band	1992	2009	2011
1	69	61	55
2	27	26	24
3	29	23	21
4	61	71	52
5	56	56	40
6	126	134	104
7	20	21	15



General impact of forest clearance:

Visible bands: brightness increases = bare ground appears 'lighter' (initially)

NIR: brightness decreases = less healthy vegetation (initially, but then regrows]

MIR: brightness increases = moisture decreases

TIR: depends on time of day and season - see thermal lecture

3. Simultaneous display

Now display the equivalent bands from each date simultaneously: **layer-> add -> RGB**

Show 1992 in red, 2009 in green and 2011 in blue (channels 1, 8, 15). Thus an increase in DN over the 15 years shows as blue/green, a decrease in red. Note that you usually have to enhance after loading channels, and that the comparable channels are separated by '7'. It is more logical to have RGB versus BGR for the dates as 2009 and 2011 are closer together.

Query some points of interest with the cursor and view the DNs at bottom to see the differences and how they contribute to the overall pixel colour.

Shades of gray including black (lakes) = 'No change'

Pick some known points - the Northern Sports Centre, pine stands across University Way, Forests for the World etc.. your known places might be different to mine ... shopping mall?

Now flip all guns 'up' one channel to show the three Band 2 channels (2,9,16). It may not be hugely different to the previous display ... check some DN values, and then up one more to view the three Band 3 channels. Somewhere here, you may see some changes in the islands at the confluence of the two rivers. What has caused that ?

Note the areas that are most 'red' or 'blue-green'

For each one, click around the image and see the magnitude of the changes (= the difference between the two DN values)- **remember to always have active the display you are looking at** (select it in the 'maps' tab on left)

Continue viewing the triplet images - flip up to view the NIR trio, and then the MIR - the two bands 5 and 7 are usually pretty similar. The MIR ones are colourful - very blue cutblocks are since 2009 and red shows regrowth (had been cleared).

Q: Which band comparison seems to show the changes best ? [For me, it was maybe bands 3 and 5] Could 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 soccer field etc..) while below that number a difference is not meaningful

4. Image differencing

In 3. above, we used display to view potential change; now we can create a new difference channel, based on your observations above - which channel might be most useful to compare ?
Keep it simple and use the 1992 and 2009 pair

Using Raster Calculator (RC)

Tools -> Raster Calculator

Subtract band 3 (1992) from Band 3 (2009) = channel 10 minus channel 3
Set output to display, and 16 bit signed channel - to retain negative and positive values
Close RC and query the DNs in areas of real change - does this pair capture the change ?
Try again using RC with the band 4 pair and then the band 5 pair
Overall I found band 5 to give the clearest result (maybe!). Re-run your best RC result and save to your PIX file (pglab8.pix) as a new layer instead of to the viewer (it should be 22?).

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 band3 diff 2009-1992

Step 2: (Option 1 - try it if you cannot figure out option 2)

creating a threshold channel THR - only if you found a useful result in the step above

Determine a numeric threshold for a meaningful difference

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 select the approx minimum DN - but raise the number if that captures too many non-change pixels
Note that you need to do it twice to capture large negative and positive values separately.

In the algorithm librarian, select THR (same as last week)

In parameters, assign the threshold minimum;

Display this new layer:: Layer-> add -> pseudocolor

the result may include some non-change areas that can be deleted later

Step 2: Option 2 Creating a resultant channel using EASI modelling rather than THR

You can use the numerical threshold(s) and provide a set of classes in a single channel for using in sieve and subsequent polygons through using EASI modeller. You can use less than and greater than statements or better yet try the use of ELSE or combining ELSEIF statements to capture all the values needed in the threshold.

Here is an arbitrary example from Scott messing with EASI modeller:

```
if %4>24 and %4 < 100 and %11 > 25 and %11 < 110 then
%22 = 1
elseif %4>= 100 and %4 =< 200 and %11 >= 110 and %11 < 210 then
%22=2
else
%22 = 0
endif
```

Remember from last week, that you can't apply SIEVE to a bitmap, so in a project you might want to repeat last week's procedure to create a new channel.

You could convert the bitmap to a vector which outlines areas of changed reflectance using task BIT2POLY - save to your pix file (ALWAYS!) and

display new vectors on top of either 1992 or 2011 colour composite 543 or 321

5. Using a transformation - TASSEL and PCA

Running Tassel to generate brightness-greenness-wetness components

An issue with the simple band arithmetic above, is which band to choose. This may be easier if we use new components that incorporate elements of all channels, such as TASSEL.

Select task TASSEL in tools -> algorithms

Click bands 1-5 and 7 for 1992; save to the pglab8.pix file

parameters = TM and NONE

log tab ... Run

Repeat for 2009 (channels 8-13 and 15)

Repeat for 2011 (channels 15-19 and 21)

You now have 3 tassel cap channels for each year (they should be channels 23-31?).

Display them in turn in an RGB composite, the matching components for each year:

- a. Brightness channels for 92, 09, 11
- b. Greenness channels for 92, 09, 11 I suspect this will be the most useful
- c. Wetness channels for 92, 09, 11

Query the values for each trio to see how different the DN's are within a colour composite for each of the tassel cap channels above.

PCA - Principal Components Analysis

PCA can be more flexible in assembling all bands from multiple years into one pool.

From tools-> algorithms, select PCA

Input will be bands 1-21, but EXCLUDING the three thermal bands

Output just to viewer - we don't need to save these ...

Parameters:

Eigenchannels: 1,2,3,4,5,6 (beyond 6 they are junky)

Raster type: 8U

Report: LONG

Log tab and Run

When its done, view the last table in the log report: eigenvectors

the coefficients give the relative loadings of each input band

Logically, a component channel which has all positive values for one year (or two) and all negative loadings for another year - would 'capture' the difference between the years, while PCA1 for example would be positive loadings for all bands, as it is a weighted average. Other channels mostly show differences between the visible, NIR and/or MIR bands for just one year. The best channel stands out prominently - can you see it ?

That channel could be used to generate a threshold image to show just large changes. On my screen they mostly show as the brightest areas in the mystery channel which you'll find. Then that output could be vectorised using BIT2POLY.

Final notes: the results are somewhat complex due to the fine variations within a city environment. I'd hope that if we selected an area different in nature - more homogeneous large areas, that might be simpler to work with ... but you only know when you try it ...

Image cross-classification (your assignment - in one file notes 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 one date and then for the second date.

Select classify -> sessions config

Pick your training channel for date 1

Run the classification.

Repeat this process for date 2

We can also re-classify areas that have stayed the same, and those that have changed

Previously, you may have something like this from Lab 4:

1 Water 2 Deciduous 3 Coniferous 4 Fields 5 Residential ...

We would look at only the classes that we think may have changed (or the matrix gets big)

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

Click on a location where you feel real change has occurred, check its DN and compare with the statistics which confirm which class it has changed from / to