

# Remote Sensing, Fall 2023

## Lab 5: Feature Extraction

### Lab goals

Satellite images like air photos can be used for manual interpretation, but because they are digital, we can use image processing techniques to semi-automatically extract vector features. The specific goal in this week's lab is to create vectors for 2-3 class features which you can clearly identify and reduce to a manageable number of polygons.

There are five main steps:

- Generate a clean layer containing the desired features –a bitmap or raster channel from THR or Ratio-Index-Transform or Classification
- SIEVE to create a manageable number (but sieve works only on raster channels)
- Generate vectors (raster to vector) –RAS2POLY or BIT2POLY or EXPOLRAS
- Smooth vectors – SMBOYLE or SMMCMaster
- Examine and clean attribute table - calculate area stats (in Catalyst or GIS)

### Sample features to extract:

- 1. Water
- 2. A vegetation land cover class

### 1. Set-up

Start Catalyst and open your copy of **bowron19aug2016.pix**

Change display to 654 and enhance

### 2. Extract water from the 2016 multispectral image

We'll first create the water bitmap like that you created in lab2 to generate a vector shapefile for water: rivers and lakes.

**A. Create a bitmap for water**, same method as you did for PG water in lab 2 (THR).

As water does not reflect IR, we use the NIR band to find the threshold value that separates water, though you will have DNs that conflict with shadows – just as in PG, .. maybe worse. Note that we'll try to solve this in the DEM lab. The maximum value for water looks to be in the 7000 – 7100 range, but don't take my word for it. In the THR menu, set the raster band to 5 (NIR) and output to Viewer. Threshold Maximum is 7xxx or whatever you decide, minimum 0. Inevitably you will grab some shadow as well, but it's easier to remove that later, than to go low and miss more water. Once you are satisfied, change output to your .pix file instead of viewer and run. This will create a bitmap layer in the file. You want everything in your 2016 .pix file.

## **B. EASI modeling** to improve water layer

We can reduce the shadow problem when we consider that water is wetter than shadowed rock, and therefore has lower DN values in the SWIR band (6). Highlight the colour composite so that the DNs at bottom show RGB instead of the bitmap or another layer.

Click in the shadows and on the water to see typical DNs in Band 6 (Red Gun). Not perfect but I estimate an approximate boundary at 6200 (?) between water and shadow. Try your best value.

To do this, we need to:

### **i. Create a new empty bitmap to take the result**

Switch from map to files tab

Right-click on the filename -> new -> bitmap layer

it will give you the new bitmap number which may be 3, if your water layer was bitmap 2

-Check to be sure by listing your bitmaps under the files tab

### **ii. tools-> EASI modeling**

This enables a basic scripting language which will be elementary for the Python fans.

In the pop-up box type these lines below: note that a bitmap is coded %% and a band =%

```
if %%2=1 AND %6 < 6200 then   (or whatever DN you found to separate water and shadow)
%%3 =1
Endif           - then click on 'Run'
```

This says that if for any pixel, bitmap 2 has water AND Band 6 DN is less than 6200, then that pixel is accepted as water in the new bitmap 3 (otherwise it's not) –

Note the most common errors in EASI modelling is to forget to add 'then' and 'Endif'

We could have also typed: (but we already created bitmap 2)

```
If %5 < 7xxx AND %6 < 6200 then ...
```

You can save your script for future use .. click on save, and name it e.g. water. It will save a file named water.eas in your folder. You can 'load' it again to re-use and not have to re-retype.

But nothing has appeared on screen, so you need to add bitmap 3 to the display:

Layer -> Add -> bitmap (and select 3 – if that is your new bitmap number)

You should find it has only reduced the number of shadow pixels but it will do for now.

Basically if we want to create a perfect water layer, we might need a supervised classification. It could have worked much better in a non-mountain scene, e.g. lowland delta.

### 3. Vectorise the bitmap to create water outlines: BIT2POLY

**tools-> algorithm library → BIT2POLY**

Input: the bitmap layer number (3)

Output: viewer

Params: smooth should be checked      RUN

If you can't see your new vector lines e.g. if they are blue, right-click on the new polygon layer in the display listing and change the colour

Now uncheck the smooth vectors box in parameters and run again, output to the viewer, AND to your 2016 pix file. Compare the result with the smoothed version to see the effect of the auto-smoothing algorithm ...

Zoom in A LOT to view the difference – the 'staircase' of pixels has been reduced, not removed

You now have two new vector layers, one smoothed (onscreen only), one saved /not smoothed.

We will use a more sophisticated algorithm to smooth the unsmoothed version, written by Ray Boyle, U. Saskatchewan. It is called SMBOYLE and is found in the Algorithm Library.

Input your unsmoothed vector layer, output to viewer and the 2016 pix file.

This is perhaps a better result - NOT smoothed in BIT2POLY but smoothed by SMBOYLE. The one smoothed only in BIT2POLY is not as rounded.

Review how they compare with the 654 composite and also load the higher res. Pan layer:

Layer-> Add -> Grayscale (and pick the Pan layer) ... it may give a better idea (or Not !).

*Q1: Catalyst also has a BIT2LINE option – describe two linear feature types on the Bowron scene where you might choose to use this option to extract suitable line features*

### 4. Polygon attribute tables

You can't sieve a bitmap to remove wee bits, only a raster, (if we really wanted to, we could have generated a raster layer instead of a bitmap) ... but we can remove small polygons either in GIS or Catalyst: right-click on the polygon layer label and pick **Attribute Manager**

The areas may be in square metres as default with UTM coordinates, and if so, we can convert to hectares or square kilometres to reduce 'scientific notation'.

Right-click on the Area column heading, select Table definition, change decimal places to 4 and display units to Kilometres. Apply OK  
Deselect Area heading – click on it

Now we can remove small polygons the ‘GIS way’.  
Select the Record dropdown, then query by -> example

Edit the statement to read:  $\text{Area} < 0.01$  (=1 hectare or  $.01 \text{ km}^2$ )  
You MUST edit using the menu provided, not your keyboard –  
Use the operator button and click on ‘entire list’ to display all values  
– if there isn't an exact 1 hectare value, click on the nearest value (e.g. just above .01)  
Click on Insert Apply OK

Now all records are gray highlighted if  $\text{Area} < 0.01 \text{ km}^2$   
Right-click on one that is selected in the left column and pick **delete**  
You have deleted all the wee polygons smaller than 12 pixels / 1 hectare

Layer-> Save as ... pick your 2016 pix file and the Polygon Layer

Layer-save as again and this time scan down a few lines to the ArcGIS shapefile, and save as shapefile .. you could name it something like water2012.shp and save in your folder. This can be directly opened in ArcGIS or QGIS – unlike the layer stored in the .pix file.

Click again in the top left column (blank to the left of 'ShapeID', and you should see a summary of stats for the water polygons, including total area (sum) for the polygons.

*Q2: a. how many water bodies are in this layer and what is their total area ( $\text{km}^2$ )  
b. What is the area of each of the two largest lakes – (Isaac and Lanezi) ( $\text{km}^2$ ) ?*

## 5. Polygon layer for another land cover class - EXPOLRAS

The EXPOLRAS algorithm tool goes beyond BIT2POLY with multiple steps to extract and refine features by thresholding, sieving and vectorizing in one operation.

First we need a layer to work with – it might be a classification, but we'll settle for the NDVI for this area, and try to extract Avalanche slopes. These are not as easy to extract as water - one might assume they mostly have the highest DN values in the NDVI layer.

Query the DNs in this layer on the avalanche slopes – they seem to be roughly 0.7 and above, but the lower values overlap with the higher values on regenerating cutblocks. We may be able to later ‘clip out’ areas beyond the Bowron Lakes Provincial Park, which itself has no cutblocks.

Load the park vector outline to see this:

Layer-> add-> vector and browse to *L:GEOG357/shapefiles/bowron-utm.shp*  
[remember to do the final click on the VEC link in the bottom window]

Find your best compromise NDVI minimum to capture most avalanche slopes, without an excess of other features - we won't need a maximum as we assume these are the highest values.

Tools → Algorithm Librarian -> **EXPOLRAS**

Input: your NDVI channel

Output: to viewer and your 2016 pix file

Params:

Threshold Minimum 0.xxxx (what did you decide ?)

Minimum Area: 12 – this is the sieve operation

Go to log tab and Run ... it should be successful

You now have a polygon layer for avalanche slopes– you don't need to remove small polygons as the minimum did this, though you may still find some small ‘donut holes’ of non-deciduous in the avalanche slopes etc..

Smoothing 1 – run **SMBOYLE** and output to Viewer and your .pix file

Smoothing 2 – run **SMMCMMASTER** the same way (on the vector produced by **EXPLORAS**), not already smoothed by **SMBOYLE**

*Q3a: how would you compare the two results in smoothness / realism -by viewing them against the composite and/or PAN layer ? I am biased as Ray Boyle was Canadian and I met him 😊*

*b. Which one does Catalyst recommend for converted raster data and why (see ‘help’ for each.*

Right-click on the polygon label in the 'maps' tab and open the **Attribute manager**.

convert units to square kms, and review the total. Save the polygons as a layer in the pix file and also save the vector segment to a shapefile (e.g. avslope.shp)

You can see all cutblocks are neatly outside the Park – of course, it is a park !

We will clip our avalanche slopes to just get the ones inside the park -see graphic below

CLIP: GRRR Catalyst has a CLIP tool, but it seems to only clip to a rectangle, so better do this in ArcGIS or QGIS. Note that you may first need to ‘repair geometry’ (ArcGIS) or ‘fix geometry’(QGIS) in the avalanche slopes shapefile, before you can clip. I’m assuming/hoping you all have semi-Jedi skills in one of the two GIS softwares ?

*Q4a: what is the area of avalanche slopes inside the park (km<sup>2</sup>) -accepting our image misses some parts of the park in the north and southeast. If you haven’t converted from metres to kms than just divide your answer by 100 – but you all knew there are 100 hectares in 1 sq. km ..*

*4b. Having removed cutblocks outside the park, briefly describe any remaining ‘problematic’ features inside the park with high NDVI but do not seem to be avalanche slopes*



## 6. Edge-enhancing Filters: FED / FSOBEL

The tools include a number of filters – some for smoothing, others for the opposite. They all sample a window of DN’s e.g. 3 x 3 or 7 x 7 and perform a type of averaging or difference result.

Edge filters may in some cases serve to highlight feature boundaries almost like vectors.

Find this tool: FED

Input channel is your NDVI, Output – viewer-grayscale (just to the screen), keep parameter defaults (3 x 3) and run.

Wow! it seems to nail the water edges, and the avalanche slopes edges are at least visible.

Now try FSOBEL – same parameters and Run – maybe even better ? for the avalanche slopes ?

Finally have a look at the effects of filter: FSHARP (no, it’s not music)

As before, pick your NDVI channel for input, viewer-grayscale, params: default, run

If you wish, increase the filter size to 11 x 11 pixels and view the result again – v. sharp !

Hmmm ... seems we could sharpen up bands 4,5,6 and create a sharper colour composite – almost like pansharping when you don’t have a separate PAN band ?

*Q5a: describe briefly how do the edge filters pick out water so cleanly*

*5b. why does water itself have such low values in the FED and FSOBEL results ?*

Send answers to: [wheate@unbc.ca](mailto:wheate@unbc.ca) by Wednesday 12 noon