GEOG 357 Fall 2024: Lab 9
DIGITAL ELEVATION MODELS

In this lab, we will include non-spectral 'ancillary' DEM data.
Many of the tasks below could also be completed using GIS software options.

Four DEMs have been extracted to match the extent of the 'Resthaven' area from the last two labs in the Willmore Wilderness. Copy over this file to your folder:
L:\GEOG357\resthaven-dems.pix

1. Viewing your DEMs

In Catalyst:
Open your copy of rh2023.pix … edit the RGB Mapper to bands 654 (enhance)
Open the DEM file – by default, it will show channels 1,2,3 in RGB

1: NTDB 1960 generated from contour lines mapped from air photos
2: SRTM 2000 from Shuttle RADAR
3: ALOS 2010 from Panchromatic imagery
4: GLO-30 2015 from TanDEM (Radar)

They are similar so the 'composite' displayed is mostly grayscale. The histograms will confirm this – maybe the glaciers have downwasted a bit, notably in recent years; note that the earliest DEM does not include canopy height while the latter two do, so there can be some apparent elevation gain in the valleys. Most variation is within the precision of the DEMs.

Display each DEM separately:
Layer-> Add-> Grayscale-> select the DEM file and first channel 1 (NTDB)
In RGB Mapper, flip the RGB to channel 2 (SRTM), then 3 and 4

Stay with the latest (and best) DEM #4
1a. Using the most recent DEM, what is the elevation of Ptarmigan Lake (in the NW image area) and Twintree Lake (SE corner) ? This is most easily done by viewing the band composite, but highlighting the elevation layer which should be ticked off (to see the lakes on the composite).

Run THR to find all land above 3048m (=10,000 feet); the highest point will be in the centre of the largest high area polygon. You can find the highest point either by querying that centre area location or just examine the elevation layer histogram for maximum value.

1b. What is the highest point in this area in elevation (metres)

DEM differencing

We could use the Raster Calculator to subtract two DEMs and display to viewer, but the DEMs need careful re-registration to avoid interpolation errors, missing data and shadows – this might be more suitable in the advanced RS course

Which is the best DEM layer to use for further analysis ?
– we need to view the shaded relief versions to see their respective qualities and confirm:

All tasks below are found in Algorithm Library -> Analysis -> DEM Analysis
Resulting output image layers may be to the viewer- grayscale (unless we need to keep them, and then we'd also write to your PIX file
In all cases, you are inputting the DEM channel as this is the mother for other layers

2. Shaded Relief (REL)

Use Algorithm Library -> Analysis -> DEM Analysis to find tool REL

Input: DEM file, channel 1 (NTDB)
Output Ports: Select Viewer-Grayscale (will display in Focus)
INPUT PARAMS TAB
Pixel X Size: 30
Pixel Y Size: 30
Elevation Step Size: 1 (= the 'step' between adjacent integer values)
Azimuth Angle of Light Source: 315 - note that it's not the default as in GIS software
Elevation Angle of Light Source: 45
Select LOG tab and run

This will display the shaded relief (hillshade) for the earliest DEM (1960)
It's not great, interpolated from contours – if you view the area in the SW corner, it's better as this is in BC and from the 1980s TRIM digital data.

Repeat REL for the other 3 DEMs and view display – you can flicker between them (turn on/off)
No need to save them, just display in viewer / grayscale

You should find DEM 4 is the best – the most recent and derived from higher resolution data, with 1-2 decimal places maybe justifiable. And no artefacts or terracing.

Viewing the shaded relief as a grey-scale image (BW). What do the DNs represent (0-255) ?
The numbers are simply on a comparative scale relative to lighting from the NW. NW facing slopes have higher DNs and SE slopes lower DNs.
Flat surfaces e.g. lakes will have intermediate DN values. You could read lake elevations by viewing the hillshade but highlighting the elevation layer.

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3. Transfer the Resthaven GLO-30 DEM into your 2023 image file

We will want the best DEM in our Landsat image file – highlight the DEM file
File-> utility-> TRANSFER
source: the DEM file (it should already be listed if you just opened and highlighted it)
destination: your rh2023.pix file
select channel 4 (GLO-30 DEM) -> add-> transfer layers
Close

Check it is there: switch from maps to files tab
Expand the Rasters list -> the DEM should be the bottom layer / channel in the rh2023.pix file
Rename it properly if needed: right-click -> properties and type its name as the label e.g. DEM

You no longer need the original file with 4 DEM layers - ALL work now MUST be done in the rh2023.pix file. It's best to remove all other files from the project:

Switch to 'files' tab; right-click on resthaven-dems.pix and 'remove from project'

4. SLOPE: task SLASP Slope gradient and ASPECT:

We will create a slope layer, but NOT aspect for the reasons given in lecture.
Input = the DEM (elevation) layer
Output = grayscale and your rh2023.pix file .. ticked only for slope
You can leave Aspect on Viewer-grayscale or PCT for interest, but don't save it to file
Accept default parameters, switch to log tab and run
Review the slope image created. The DN values should be somewhere between 0 (flat) and 90.
Likely it creates 32-bit real layer with overkill precision decimals **
** show me your slope layer before continuing – I've had some odd results and may drop slope

5. Incidence: ANG le of Incidence

Remember from lecture notes, we can get around the issue with Aspect that it is circular but still retain a layer that indicates different lighting i.e. Incidence

Input is the DEM channel again
Pixel X Size and Y size are 30; Elevation step size = 1
Light source: we have the sun's azimuth and elevation angle from the scene metadata which is included whenever you download image data from the EarthExplorer website.
This will be the 2023 text file (.txt) in the Willmore folder on L:\GEOG357, double-click on it

- you don't need any software for a text file and look for these two parameters:

Sun Azimuth = 160 and Sun elevation = 40.5
Light source distance is technically ~150 million km (the sun) - 150000000 is good enough
Output to grayscale AND your image pix file
Run ANG

What are the DN values ?.. incidence values are between 0-90 (+ steep shadowed slopes)
How are the DNs different to the hillshading ?
The image is like an inversion with the sun in the SE but now they are meaningful
But note some 'dead zones' in the shadowed areas with 'N/A' given as the result - = no light
These can be removed using EASI modelling, but not this day !

Q2a. What are the minimum and maximum incidence values
Q2b: what is the incidence value for flat terrain (lakes): why is this obvious in hindsight ? (given how Incidence is created …)

6. Classification

One reason to create these DEM channels is to try to improve classification in mountain areas.
You will need all these input layers in the same file (rh2023.pix)
OLI bands 4,5,6, Elevation, Slope* and Incidence (* depends on how it worked out)

Unsupervised

Try an unsupervised classification – you will need to add 4 unsigned 16-bit new layers
Use Isodata with 16 classes and defaults
a. use as input bands 6,5,4 (and as RGB display)
b. repeat with bands 6,5,4, plus DEM (elevation), Slope (*as above) and Incidence ...
- does adding DEM channels help ? Perhaps not much due to the strong shadows …

Supervised

Run a supervised classification with the same 6 input layers as in b. above – use two empty layers for the training channel and classification output. See lab 3 if you need a reminder on the process. I suggest these training classes / seeding:

water - seed both clear lakes and silty meltwater glacier lakes
glaciers - seed both accumulation (snow) and ablation (ice) areas
bare-rock - sunlit and shaded, and different shades of red in the composite
fires - the two regenerating fire areas
coniferous – dark green areas in the valleys
pine - these show as brown-green in the valleys, discoloured by pine beetle attack
alpine - looks yellow-green, above the tree line
sub-alpine - these show as a brighter green within or next to the alpine, more sparsely treed
avalanches - not as prominent here compared to Bowron – look for their distinctive shape

meadows - riparian un-treed areas in the valley bottoms usually next to rivers

Review and save your signature separation report for reference to check your seeding /results

Q3. Submit the signature separation report in your answers; comment on any low values and why those classes may be tough to separate – no need to get a perfect table / report

Preview and then Run the classification – Maximum Likelihood (no null class).
Save the classification report.

Q4. Please attach the classification report – but only down as far as the line with KAPPA COEFFICIENT - Mine was 0.898 … can you do better ? 😊

Q5. The Copernicus GLO-30 DEM represents the best available DEM for most parts of the world, and where you might go to download a DEM for projects, except perhaps for BC and local areas covered by LiDAR. Use your browser / google to answer Q5.

a. Is this GLO-30 DEM a terrain model (DTM) or a surface model (DSM)
b. There is a downloadable higher resolution (10m) DEM for some places – which ones ?

Submit answers as usual via Moodle as .PDF

Questions repeated here:

1a. Using the most recent DEM, what is the elevation of Ptarmigan Lake (in the NW image area) and Twintree Lake (SE corner) ? This is most easily done by viewing the band composite, but highlighting the elevation layer which should be ticked off (to see the lakes on the composite).

1b. What is the highest point in this area in elevation (metres)

Q2a. What are the minimum and maximum incidence values

Q2b: what is the incidence value for flat terrain (lakes): why is this obvious in hindsight ? (given how Incidence is created …)

Q3. Submit the signature separation report; comment on any low values and why those classes may be tough to separate – no need to get a perfect table / report

Q4. Please attach the classification report – but only down as far as the line with KAPPA COEFFICIENT - Mine was 0.898 … can you do better ?

Q5a. Is this GLO-30 DEM a terrain model (DTM) = the bare ground, or a surface model (DSM)

b. There is a downloadable higher resolution (10m) DEM for some places – and which ones ?

7. FLY (like an eagle) – optional ‘fun’

It’s like Google Earth, with a better band combination, but basic Landsat pixel resolution
Run the flight simulator from the Catalyst menu bar options .. (‘eye in the sky’)

When it starts pick: file-> Load DEM + RGB
in the next window, .. select the DEM channel (navigate to it, select and close) then select 6-5-4 in your copy of the 2023 image (select and close)

The defaults fly you **too low**, and the window is small, so change using edit -> options
edit-> perspective->position/speed/direction - change vertical position to 5000, angle to 50
Need more vertical exaggeration: edit-> perspective-> change height magnification to 2

FLY control panel:
left button allows you to change parameters - you will need to increase 'elevation' from 1 to 3 to exaggerate terrain
second button starts a FLY
third button displays a vertical view … check out options etc..

see if you can replicate this view taken by a student in this class a few years ago - – she seems to be near 337000, 5915000 – see photo and annotated image