Remote Sensing, Fall 2022: Lab 8

DIGITAL ELEVATION MODELS

In this lab, we will use non-spectral 'ancillary' DEM data – nothing to grade, but I left the questions in 'for your fun'

A. PG - Importing the DEM

Start Catalyst, open your PG 2013 pix file and display the optimal colour composite.

I've pre-prepared a DEM to match from the BC TRIM
- we are going to transfer the DEM as a new layer (channel) into your image .pix file.

Layer-> add-> grayscale … and browse to find **L: /GEOG357/pgdem.tif**

Open/Display the new TIF file and ensure it matches the Landsat in extent
Right-click on the DEM .tif and -> overview of layer

What is the pixel size: switch to files tab, right-click -> properties and view the last tab
It's part of the BC TRIM provincial DEM created at a different resolution to the imagery

You can view it this way, but to include it in analysis with your imagery, you need to **transfer** the DEM layer into your PIX file

File -> Utility -> Transfer (NOT translate or you will destroy your output data file)
source : pgdem.tif
destination: your PG 2013 .pix file
select all-> 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
Rename it properly - right-click -> properties and type its name as the label e.g. DEM
Note that it is 16bit signed (although no negatives), whereas the image layers are 16-bit unsigned
switch tab back to maps from files

1. Viewing your DEM

Add the new channel as grayscale:
layer -> add -> grayscale -> …. Select the DEM layer

zoom in so you can see individual pixels and compare them with the Landsat (switch the DEM layer on/off) ... transferring the DEM has converted pixel resolution from 25 to 30m to match

.. click the mouse on a few locations and note the elevations in metres; view all values in layers-> histogram and the cursor panel, what are the minimum and maximum values ?

I have left in the questions which won't be graded, see if you can answer them anyway ?
Q1. What is the elevation of a. Shane Lake b. Tabor Lake ?

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 layer for other layers

2. Shaded Relief (REL)

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 like in GIS software
Elevation Angle of Light Source: 45
Select LOG tab and run

Look at the shaded relief as a grey-scale image (BW). What do the DNs represent ?
The numbers are simply on a comparative scale relative to lighting from the NW

Note how well it displays topography:
The bowl versus Cranbrook Hill, the dissected glacial deposits in the Hart, sinuous eskers north of the Nechako, flat area near the airport (you can see the roads as they are raised on gravel above the wet clay lands of beds of glacial lake Prince George); note the general NE-SW trend of the small hills on Cranbrook Hill (=direction of glacial advance/retreat), and how clear Tabor Lake is compared to the DEM. There is some vertical striping from the TRIM "mass points'.

3. Some bitmap flooding

a. In the same way that we tried to extract water using a threshold value in the NIR band for water in Lab 2, let's do the same here by finding and 'flooding' the image with a rise in water level to 600metres elevation.

Tools → algorithm librarian and find THR
Input is the elevation channel
Output to viewer-PCT
In the parameters, add 600 for maximum
If you needed a minimum (we don't), enter the lowest elevation for this DEM
Run and you should see the landscape 'flood' to 600 metres.
Turn off the DEM channel so you can see the flooding over the image landscape (543 composite)

When the glaciers retreated ~12,000 years ago, impounded meltwater formed *Glacial Lake Prince George* which reached up to ~ 760 metres elevation ..exactly the height of UNBC Agora.
Rerun THR with a maximum value of 760 – output to viewer-PCT and your pix file.
Zoom in on UNBC to see where the lakeshore would have been.

b. ARE task – Area under bitmap
This calculates the area under the bitmap (area flooded in this image)
Input elevation channel
Mask = the bitmap you just created
Output – you get a numeric output 'actual area' and 'projected area'

Q2a: what are the two area values and what do they mean (the help is not helpful),
hint: they would be the same if it was flat – ArcGIS gives similar dual results

c. VLM task
This calculates the volume under the bitmap – in this case the volume of flood water
The answer may be in scientific notation, but the 'output parameters' tab also gives the answer.

Q2b. What is the volume of water with the lake at 760m
(= just in this image area … the lake extended much further beyond)

Note: if you wanted to calculate the unflooded area and volume of land above the lake level, you'd simply do the reverse threshold and find all land above 760m

OK, enough of PG, and off to the Rockies …..

4. Preparing the Resthaven DEM

Let's enjoy a more exciting DEM:
File-> New project
No need to save the PG 'project' unless you want to load this exact setup again
– in that case, save and give it a name

Open your 2015 Resthaven file from last week (rh2015.pix) and the stretched 654 composite

As this is across the Iron Curtain in Alberta, there is no 'TRIM' DEM data, but I've downloaded the federal DEM from 'Toporama' online and clipped it to fit our image area stored in L/GEOG357/willmore/rh-dem-utm.pix (I saved as .pix, but it could have been .tif)
Open this file in the project (no need to copy it) and we'll transfer it into our image file

File-> utility-> TRANSFER
source: the DEM file (it should already be listed if you just opened it)
destination: your rh2015.pix file
select all-> 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
Rename it properly - right-click -> properties and type its name as the label e.g. DEM
Again it's a16 bit layer, like the image bands, but 16S while the bands are 16U.
switch tab back to maps from files

Note: all channels must be in the same pix file for analysis and display: every new layer you create in the lab becomes a new channel in your 2015 .pix file

Viewing your DEM

Remove the original DEM file from your display (the one stored in L:\labs)
Add the new transferred DEM channel to the display: layer -> add -> grayscale -> pick the 2015 file -> DEM channel -> Finish

.. click the mouse on a few locations, and view all values in **layers-> histogram**

Q3a: what are the minimum and maximum elevation values ?

You could flood this landscape too if you wished using the same method as in A. for PG, but it's too beautiful to flood, unlike downtown PG 😊

5. Shaded Relief (REL)

Output Ports: Select Viewer-Grayscale - no need to save this as a channel as it's for viewing
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
Elevation Angle of Light Source: 45

Select LOG tab and run
It's a bit scrappy – the federal models from digitised map contours are not as smooth as the BC TRIM directly from air photos, but it will do. You can see the difference in the SW corner section in BC where it is derived from BC TRIM data.

Q3b: What is a typical shaded relief DN value on a flat slope e.g. lake ?

6. Slope gradient (and ASPECT): SLASP

Input = the DEM channel
Run and display slope in viewer-PCT, and also output to your .pix file
We don't have any need for Aspect, so don't tick any output options for Aspect

query the slope values: what are typical DNs on the slopes inside the lakes, on mountain tops ?
(You must highlight the slope layer in the TOC list)
AARGH!! they are in 32-bit - overkill ! … no worries - we can use the decimal slope layer – it's just 'false precision' as the model is not good enough to warrant such detail. For serios work we can easily convert it to 16 bit integer elevations

We could use slope to clean up your Bowron water bitmap from Lab 6. – or PG water in lab 2.
Obviously if slope is not 0 (flat), it can't be water, but more likely shadow on slopes
In tools-> EASI modelling, we'd write a condition that water bitmap must =1 AND slope = 0
…. that would remove shaded sloping pixels (or maybe < 2 in case of edge pixels)

7. Incidence: ANG le of Incidence (optional)

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
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 only text file (.txt) in the L\geog357\willmore folder.
View it – you don't need any software for a text file and look for these two parameters:

Sun Azimuth = and Sun elevation =
Use the numbers given in the .txt file
'Distance’ is technically 150 million km (the sun) but 100000 is good enough

Output to grayscale AND your image pix file
Run ANG
What are the resulting DN values ?.. incidence values are always between 0-90
How are the DNs different to the hillshading ? – quantitatively they are now meaningful

Q4. What are the minimum and maximum incidence values

7. SEENARE (visibility) – (same as Viewshed in ArcMap) – Very Optional

Input location with DEM as input layer; it will produce every pixel visible from that point -
Try it from this location: 337000, 5914000 and elevation 2150 (metres)
This creates a bitmap, though we won't use it further.

The last section of the lab uses 'Fly' – like ArcScene or Google Earth to generate perspective views. Before 2005, this software was … WOW! but now everyone is used to GE, though it only uses the visible bands, so is not as contrasty.

8. FLY (like an eagle)

It's like Google Earth, with a better band combination, but lower Landsat res. here
Run the flight simulator from the Catalyst options .. (eye in the sky) – 7th option in Catalyst bar

When it starts pick: file-> Load DEM + RGB
in the next window, .. select the DEM channel (navigate to it, select and close) and then select 6-5-4 in your copy of the 2015 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..

9. Classification – Optional or for the project

One reason to create these DEM channels is to improve classification in mountain areas like BC.

I'm thinking this lab is already long enough .. it would not take long with unsupervised, but likely needs supervised e.g. to create training areas with sunlit and shaded samples for bare rock. This would be a possible project option.

You could try an unsupervised classification –
a. using as input only bands 6,5,4
b. repeat with bands 6,5,4 plus DEM (elevation), slope and Incidence ...
- does adding DEM channels help ?

Or you could start looking for project data …..
Note that if you like DEMs, we can download for anywhere in the world – or even other planets !