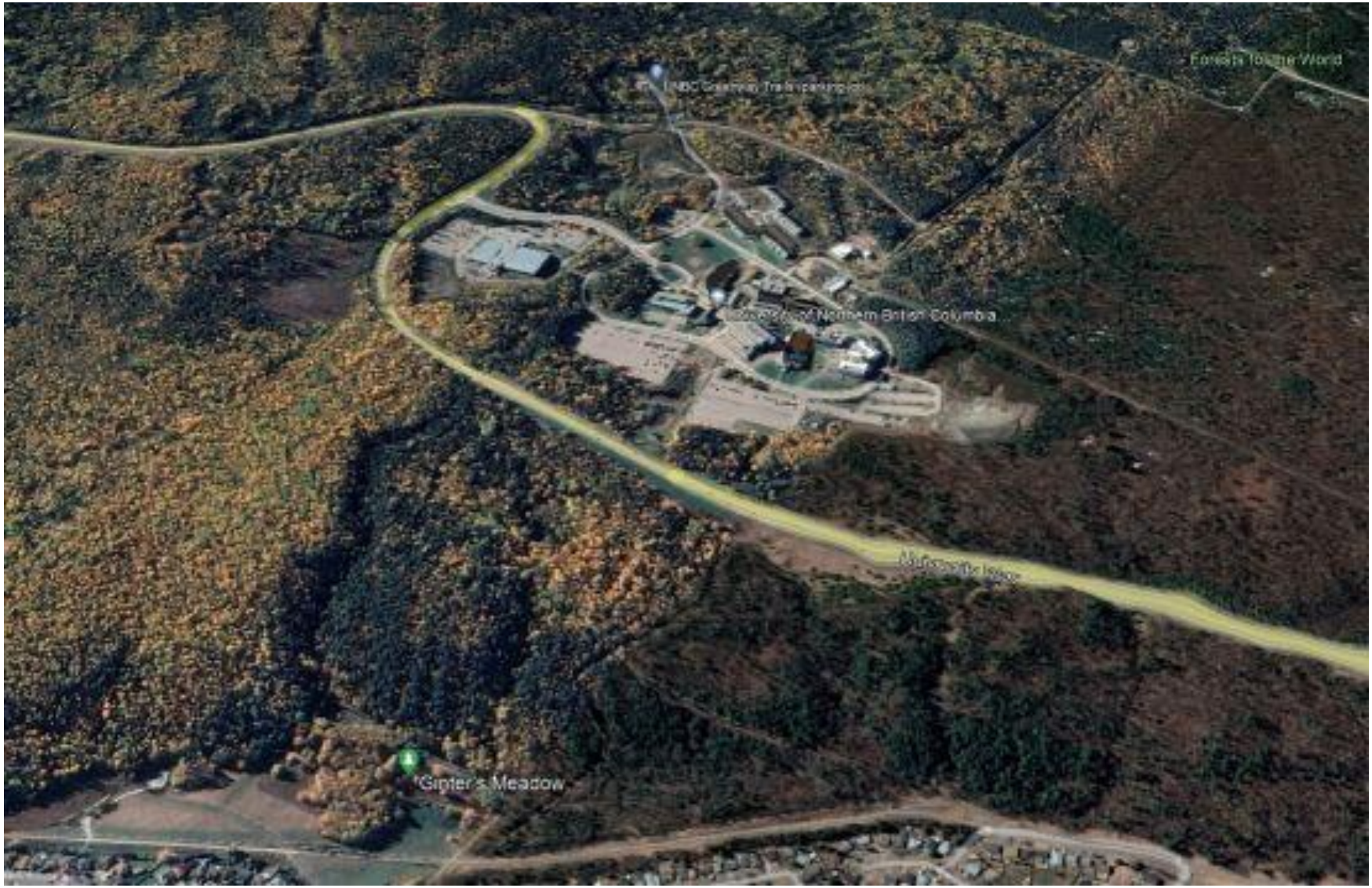
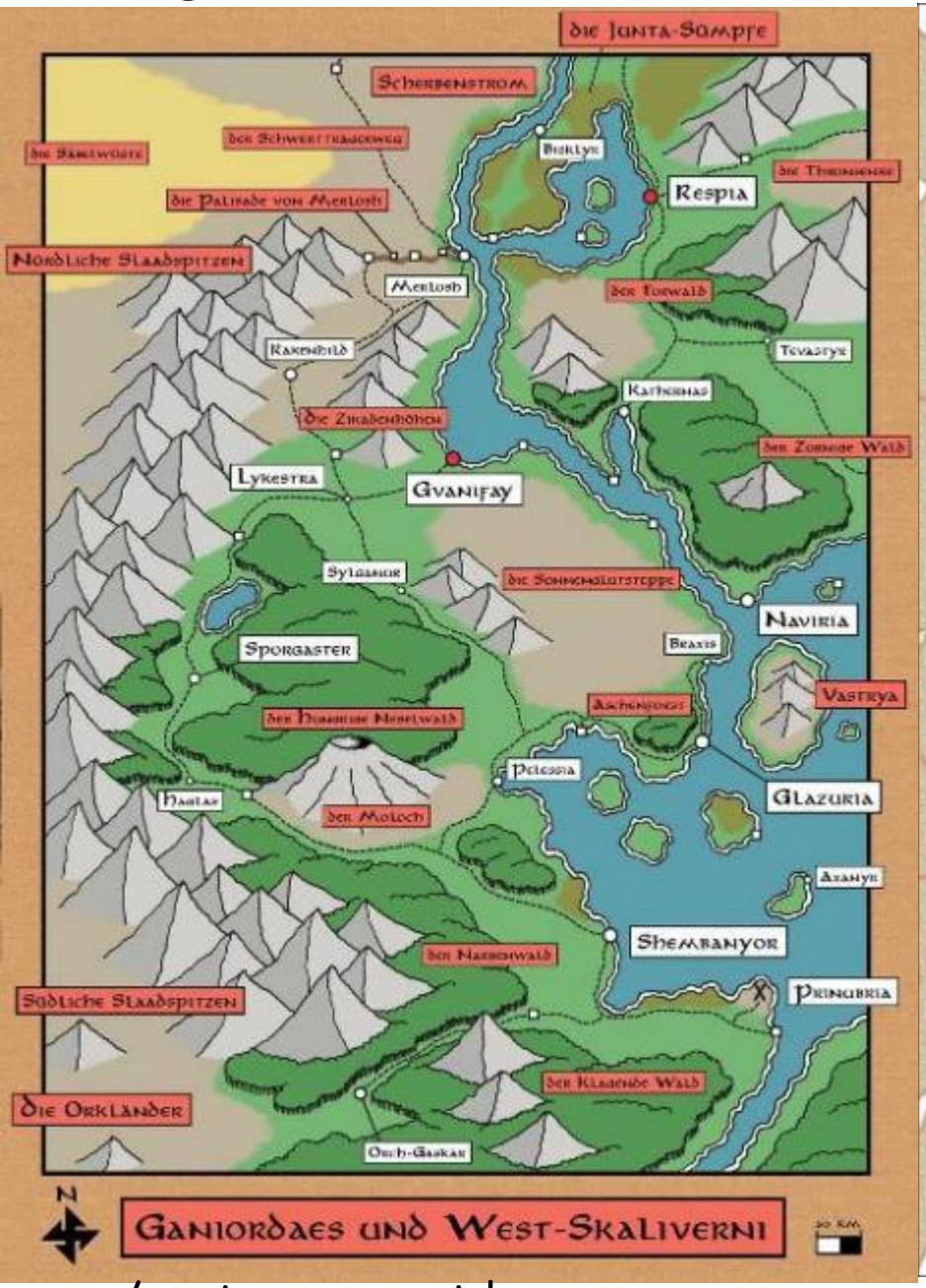
Digital Elevation / Terrain Models DEM / DTM

How has relief depiction changed with digital mapping / GIS ?

‘Geovisualisation’



1. Sugar loafs: still used to show rough location of mountains – or ‘ye olde looke’



copy/paste … repeat !

2. Hachures

They show slope by line thickness and direction

NOT a common software option

http://mike.teczno.com/notes/hachures.html

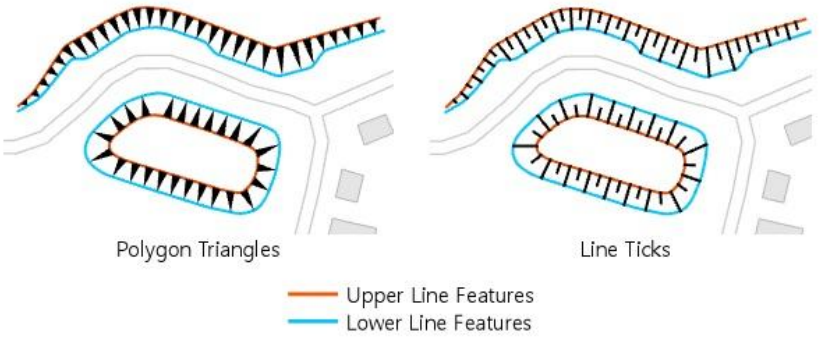
Generate Hachures For Defined Slopes (Cartography)

ArcGIS Pro 3.0 | Other versions | Help archive

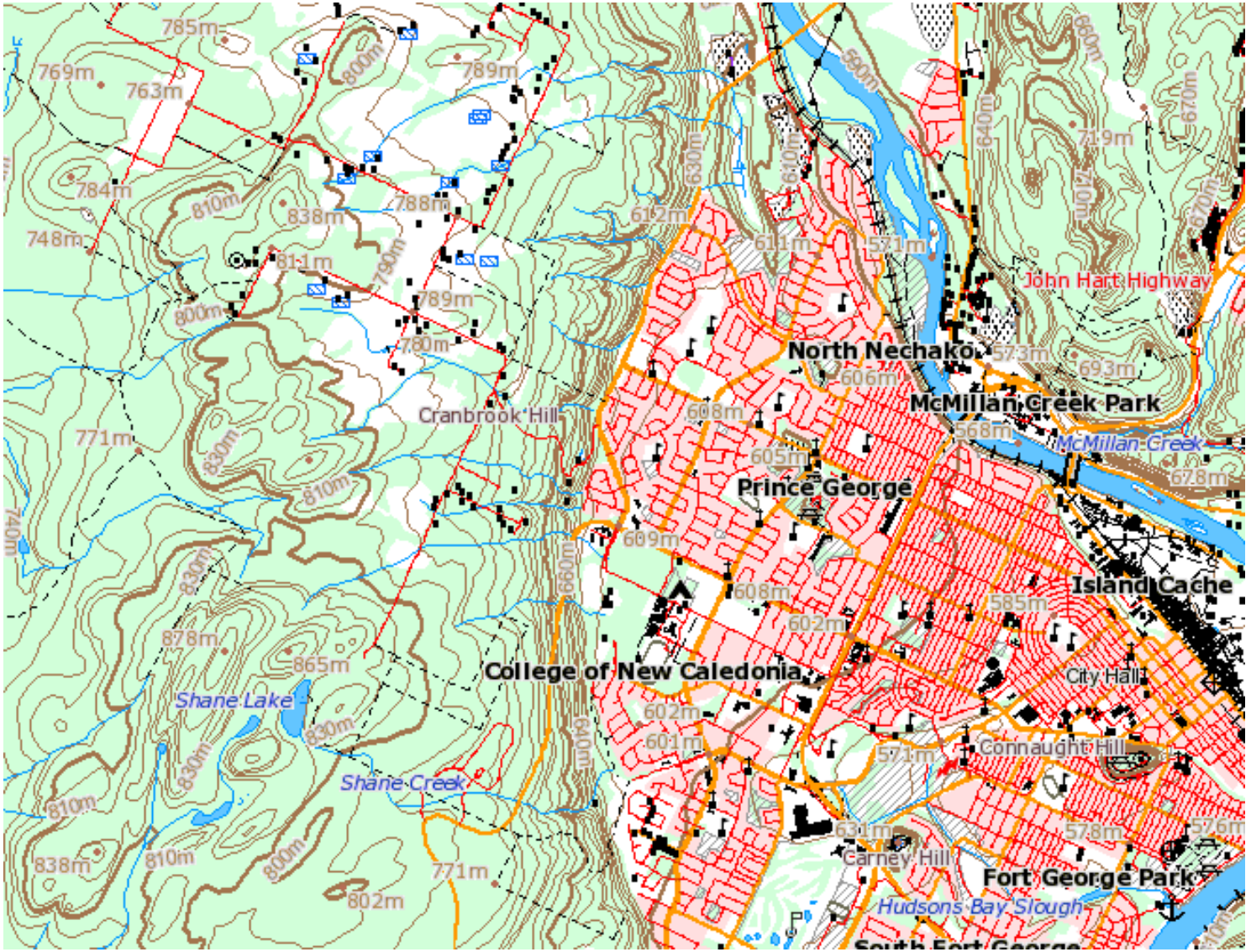
Summary

Creates multipart lines or polygons representing the slope between the lines representing the upper and lower parts of a slope.

Illustration

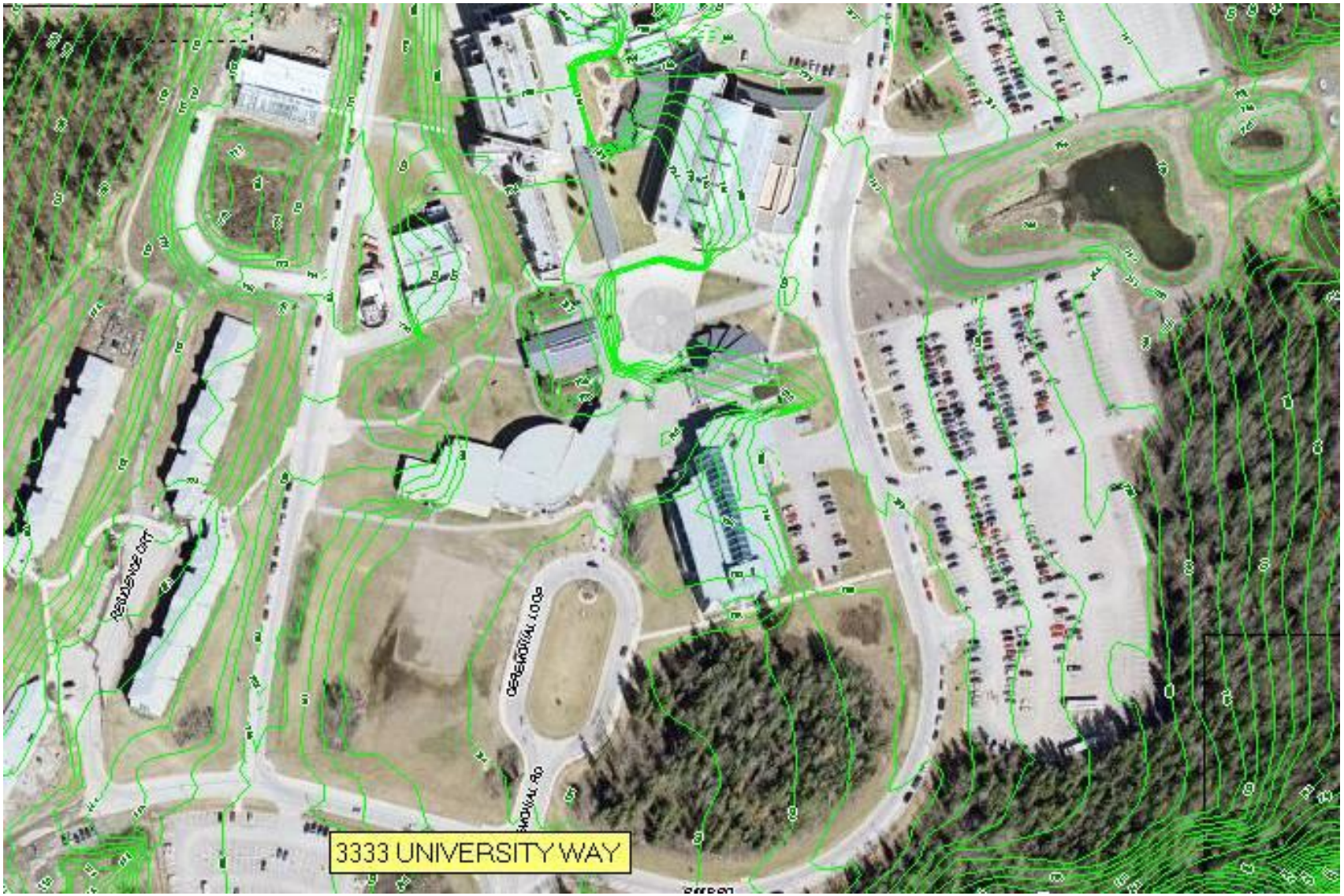


3. Spot heights and 4. Contours – digitised from printed maps – digital layers



The National Topographic DataBase (NTDB) is the digital equivalent of the (13,350) printed maps - download from Http://www.geogratis.ca

Contours are a standard layer in topographic databases and web map display.
e.g. PGmap; but here were generated from DEM

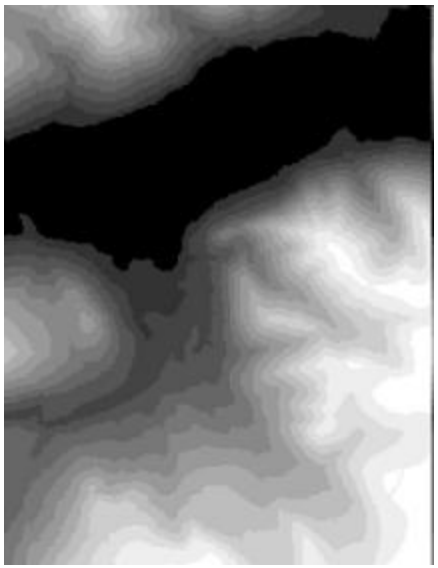


https://pgmappub.princegeorge.ca/Html5Viewer/?viewer=PGMapMobile

Digital Elevation Models (DEMs)

A DEM is a continuous grid of elevation values - one height per pixel

They are the modern equivalent of terrain elevations previously stored in contours



1122	1112	1101	1100	1106	1112	1116
1119	1116	1104	1091	1093	1096	1098
1107	1104	1099	1083	1078	1078	1079
1097	1094	1092	1083	1064	1066	1066
1091	1088	1082	1075	1060	1056	1053
1085	1079	1073	1063	1055	1049	1041
1075	1070	1064	1058	1048	1039	1036
1066	1060	1054	1049	1041	1031	1025
1056	1050	1044	1039	1033	1026	1030
1047	1040	1035	1029	1025	1025	1024
1039	1033	1026	1023	1023	1023	1023
1030	1025	1023	1023	1023	1023	1023
1023	1023	1023	1023	1023	1023	1023
1023	1023	1023	1023	1023	1023	1023

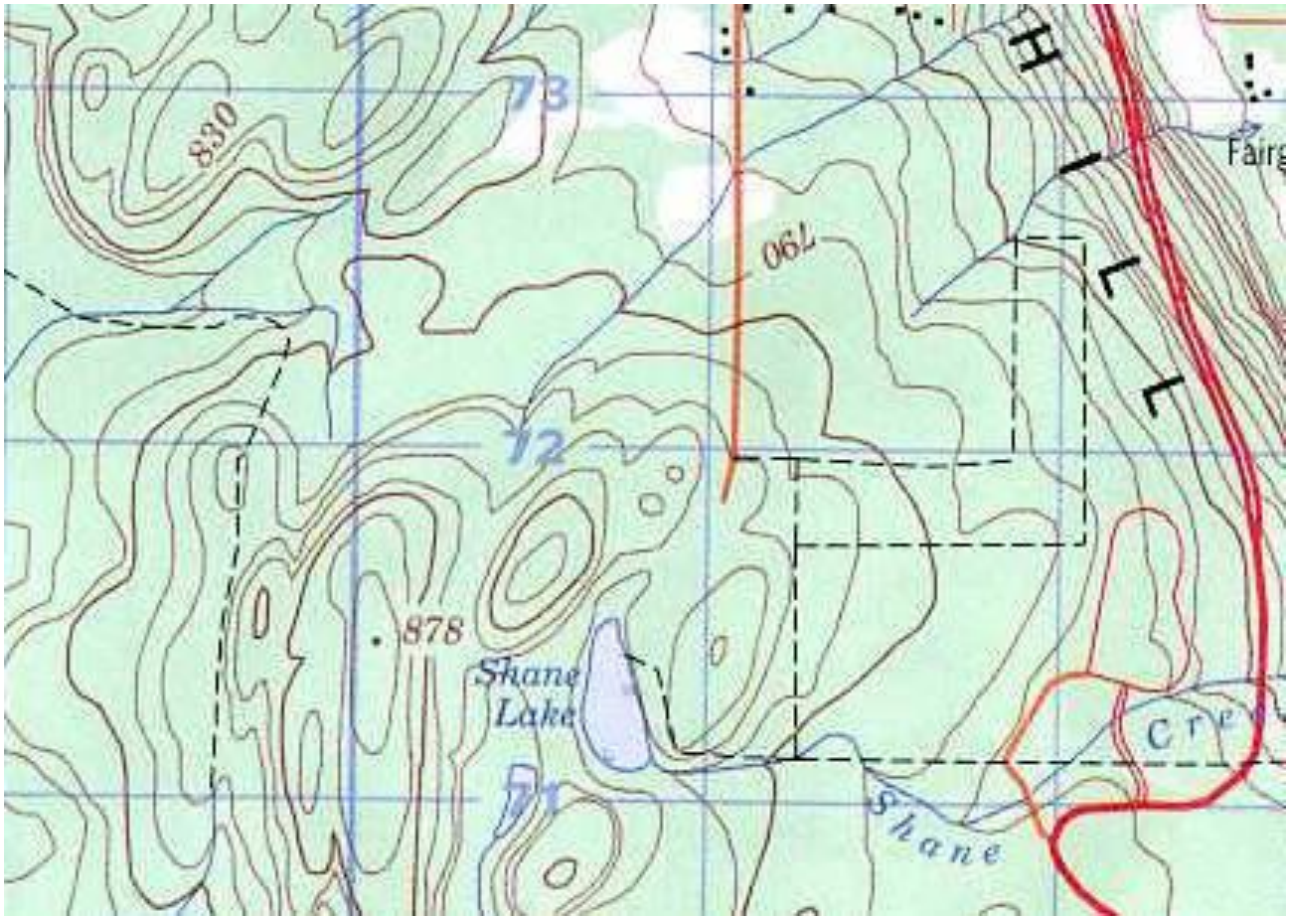
Elevation values in metres

DEM creation methods

A> by digitising contours (e.g. NTS maps -> NTDB layer)

- Done for all of Canada (~1985-95)

stereo photos -> contour lines -> digitised lines -> interpolate to grid



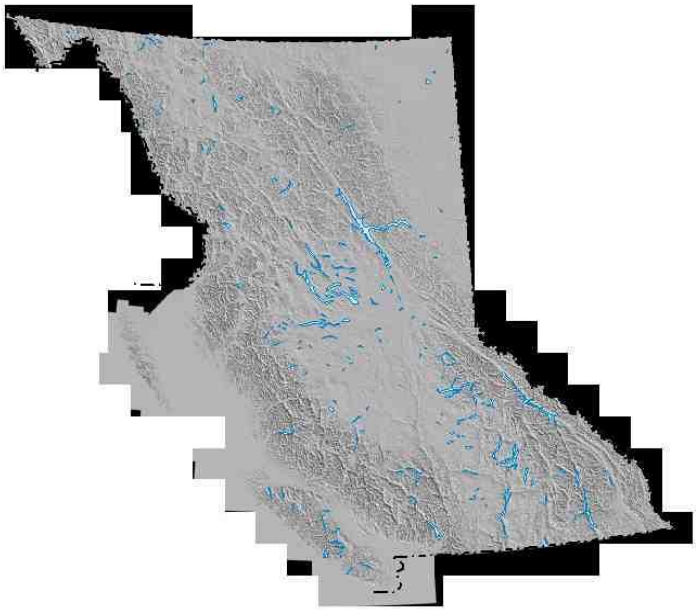
Contours are not DEMS, but can be used to create them ..

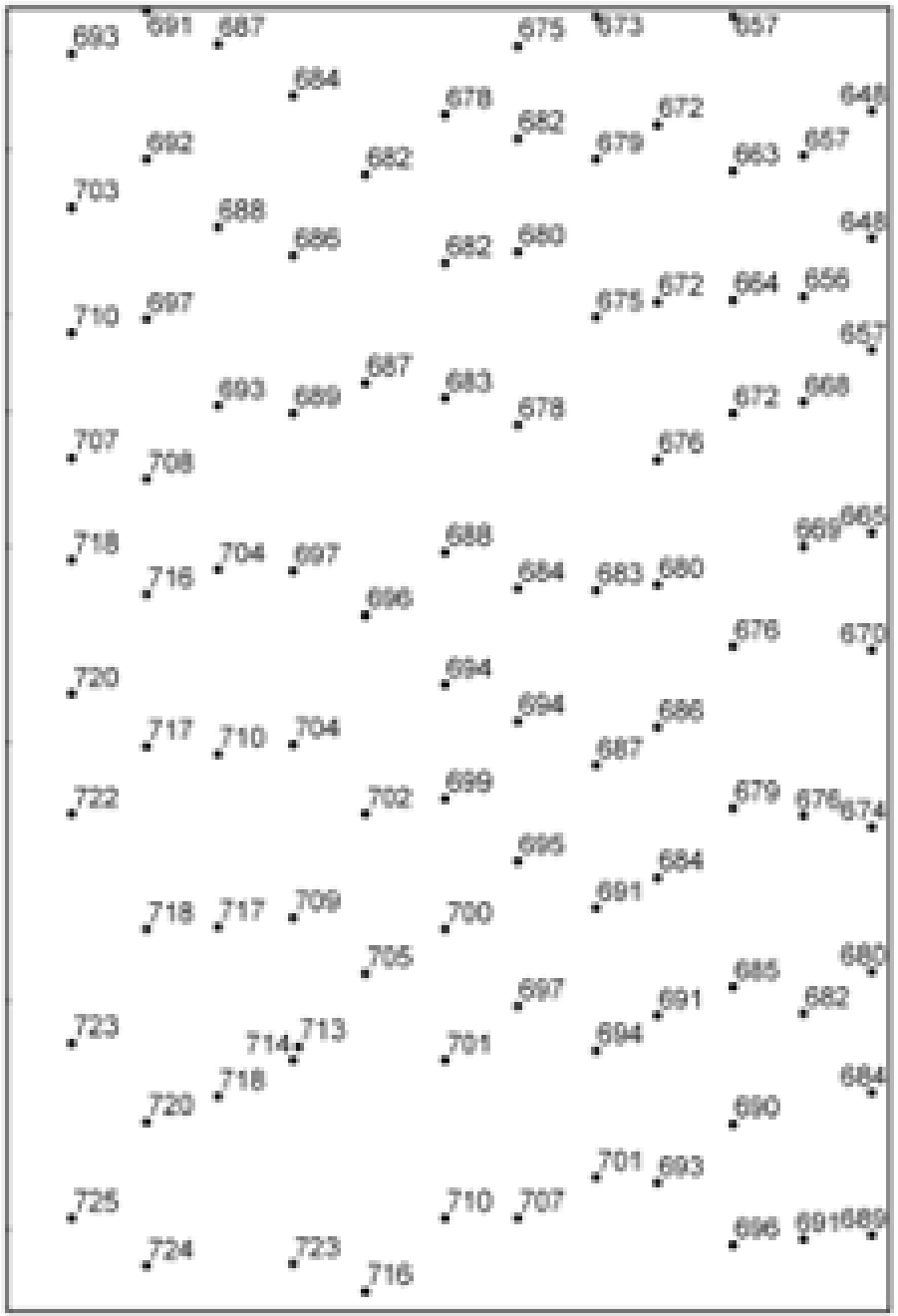
Contours are 1-dimensional (length) … with no info between the lines

B. Digital stereo-grammetry: (e.g. BC TRIM 1980s)

This is a smoother option, captured directly from aerial photographs

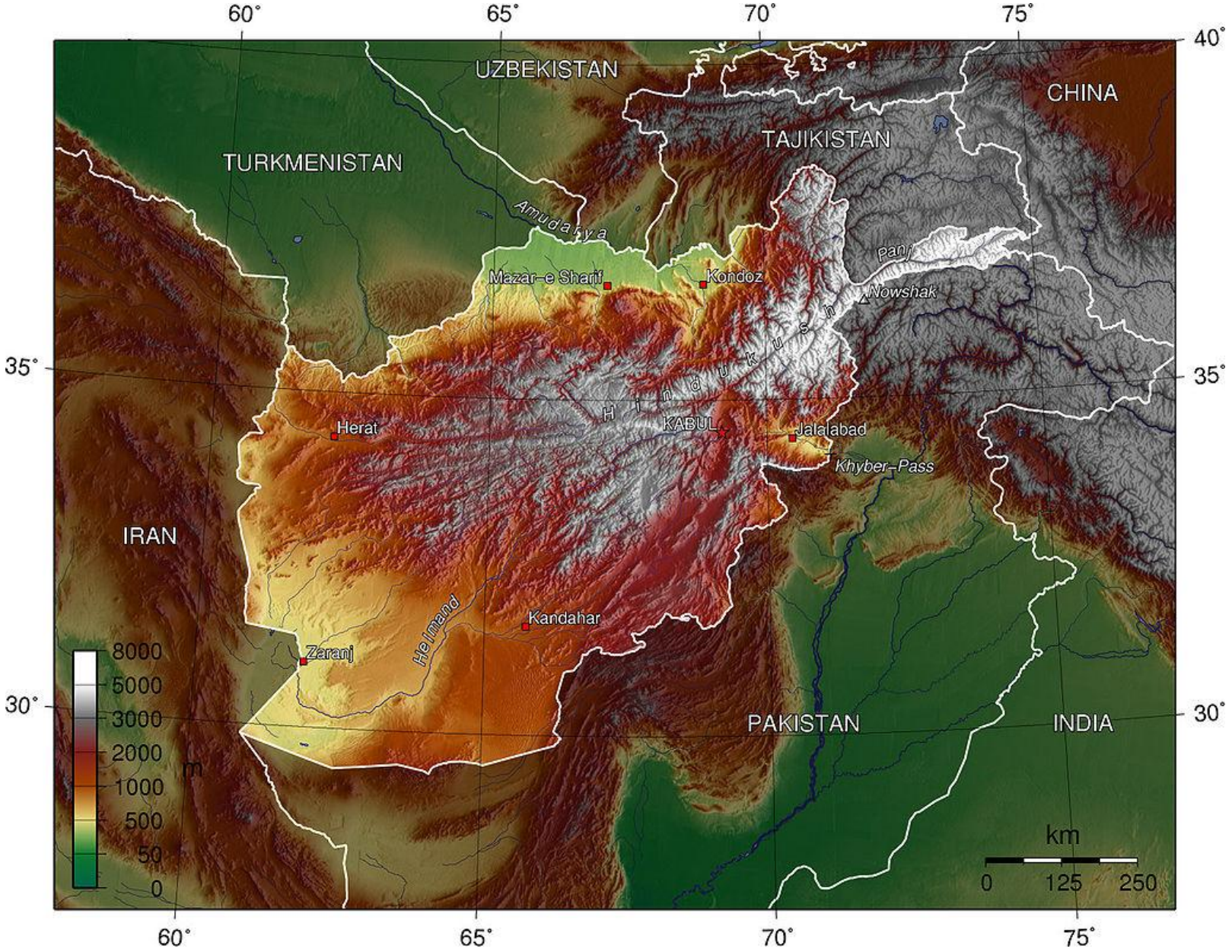
stereo photos -> mass points -> convert to raster GRID
ArcGIS: 'topo to raster'





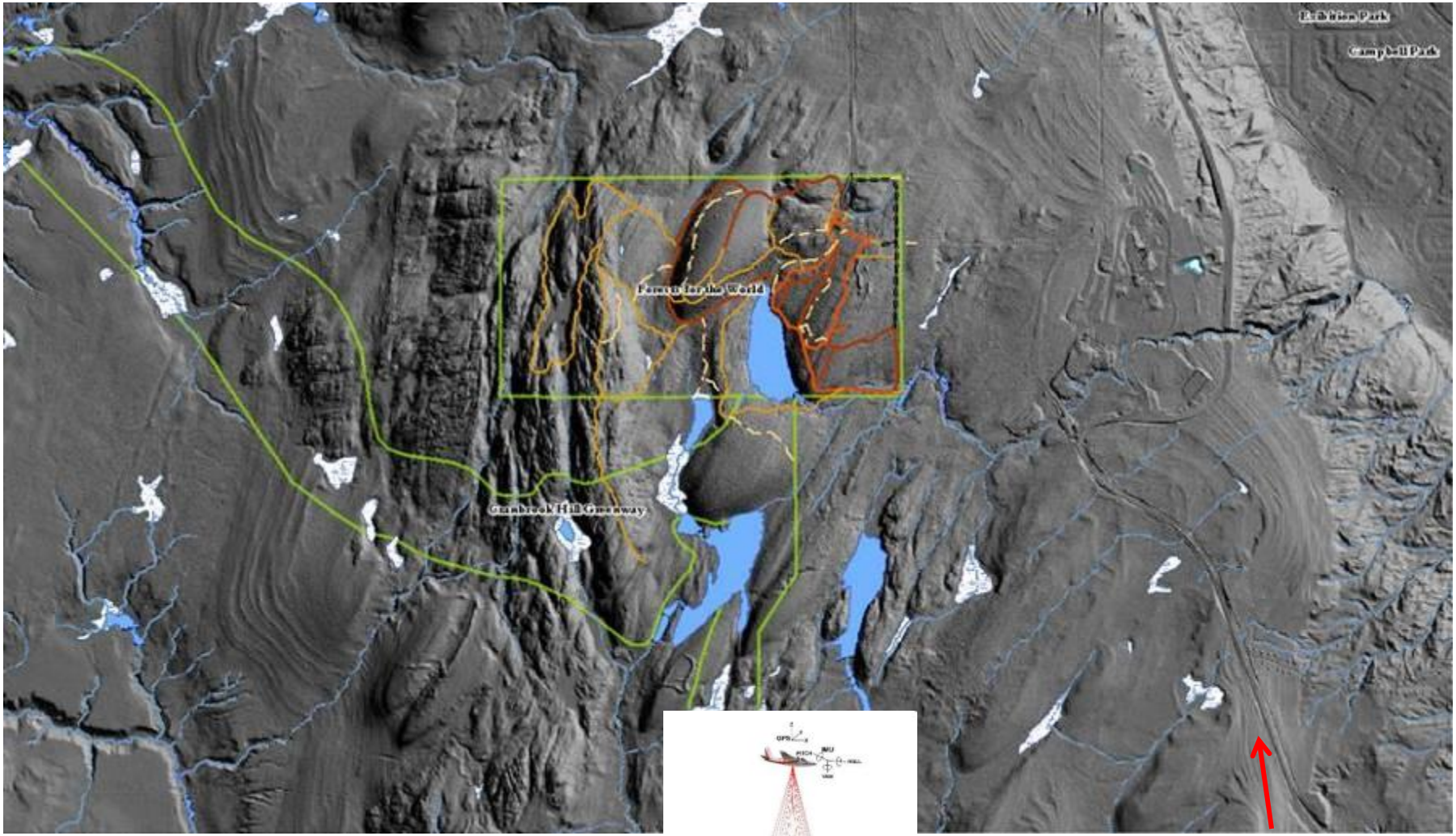
2000-> C. Direct image grid DEM

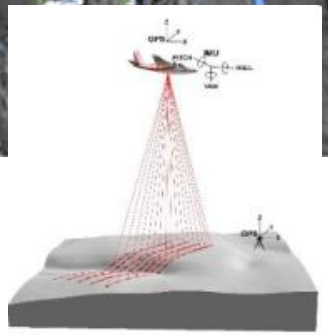
From satellite raster imagery (1-100 metre pixels)



D. LiDAR DEM > 2000 (PGmap, 2014) 1m pixels

https://pgmappub.princegeorge.ca/Html5Viewer/?viewer=PGMapMobile

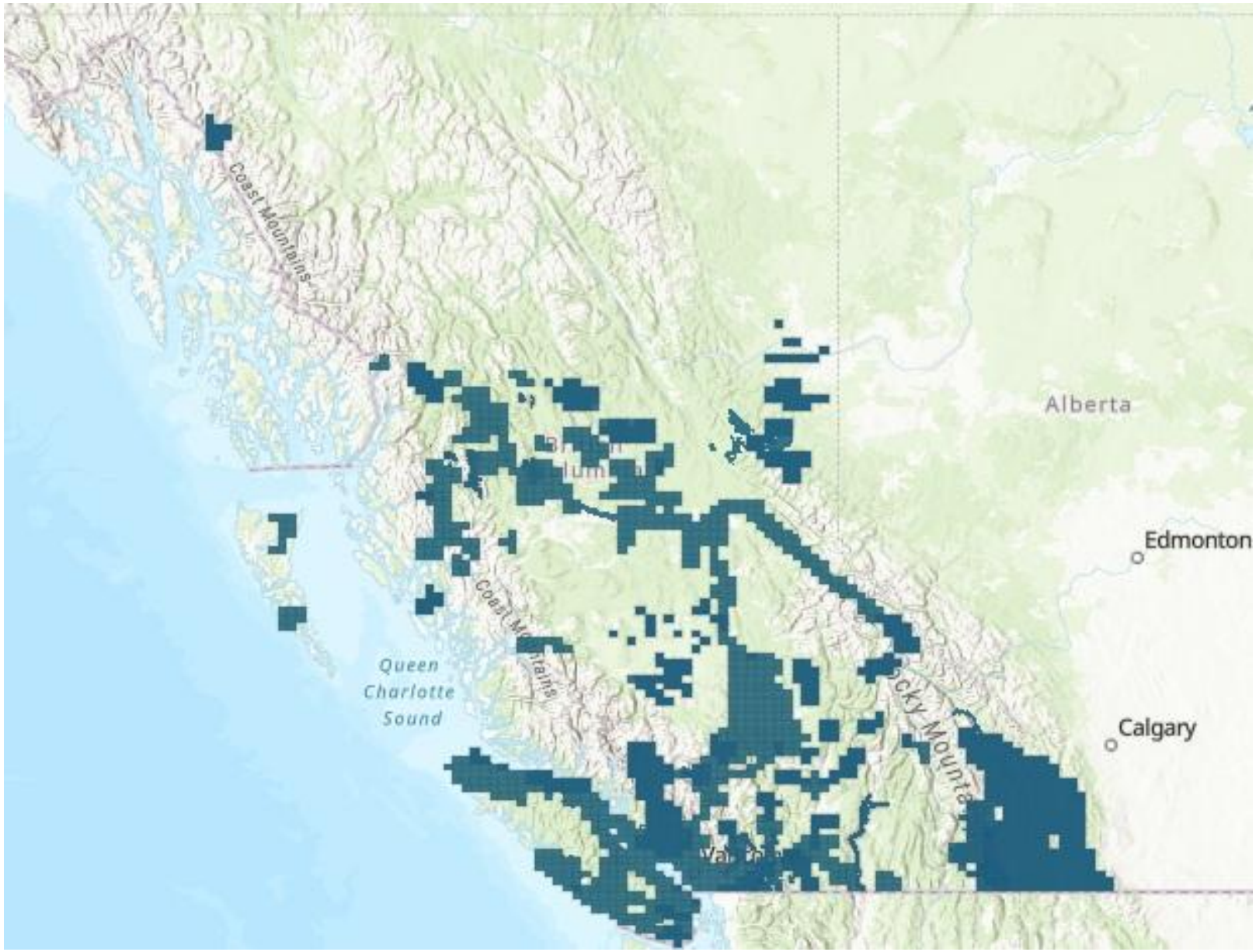




Vertical resolution ~30cm

'Glacial Lake PG'
beaches~10,000 BC
~760m elevation

BC LiDAR data portal: free download



https://lidar.gov.bc.ca/pages/download-discovery

DEM (raster GRID) data

DEMs have been created at a variety of scales by different agencies

Many can be downloaded free –

AGENCY	SCALE	TYPICAL RESOLUTION (metres)	
D. Municipal	1: 5,000	1	e.g City of PG
B. Provincial	1: 20,000	25	BC TRIM
A. Federal	1: 50,000	30	NTDB (Canada)
A. Federal	1: 250,000	100	
C. Global	1: 100,000	30/90	SRTM (Radar)

e.g. Google Earth

A: From digitizing contours
B: Masspoints from photogrammetry
C: satellite image data
D: LiDAR

Summary of common relief depiction methods

TECHNIQUE	COMPONENT	FEATURES
Sugar loafs	shape	Simple, stylistic
Hachures	slope	much ink, no heights
Spot Heights	elevation	non-visual data points
Contours	elevation	heights, 'abstract '
Hyps. tints	elevation	Layer colours
Shaded relief	aspect	Visual, artistic
Tanaka contours	aspect	visual but 'noisy'
Slope maps	slope	uniform slope areas
'3D' perspectives	shape	visual, no fixed scale
Physical models	all	true 3D – takes up space

Manually created from contours, but now DEMs

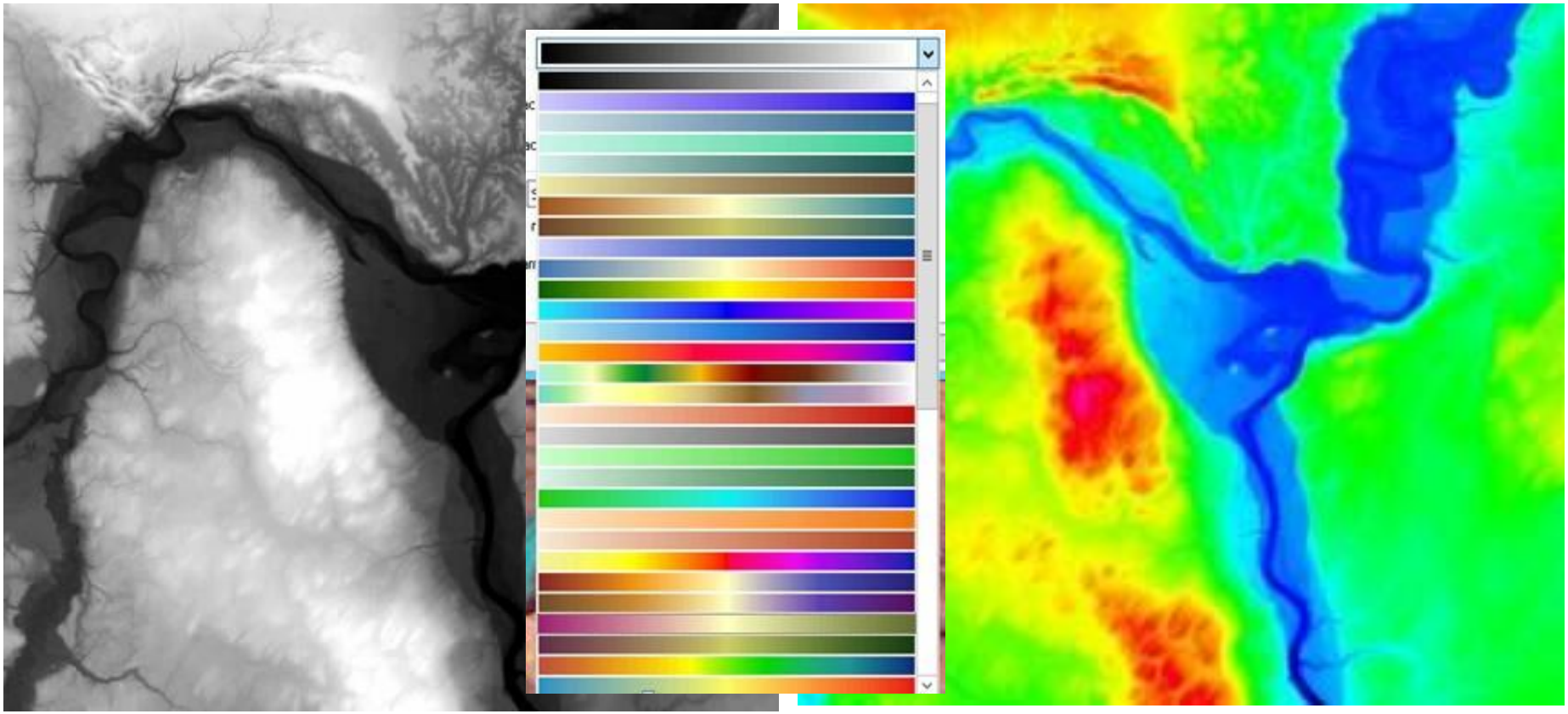
5. Hypsometric Tints (relief methods)

Generated from DEM

Selection of hues, chromas from colour sequences

DEMs displayed as grayscale or a colour ramp -> 'tints'

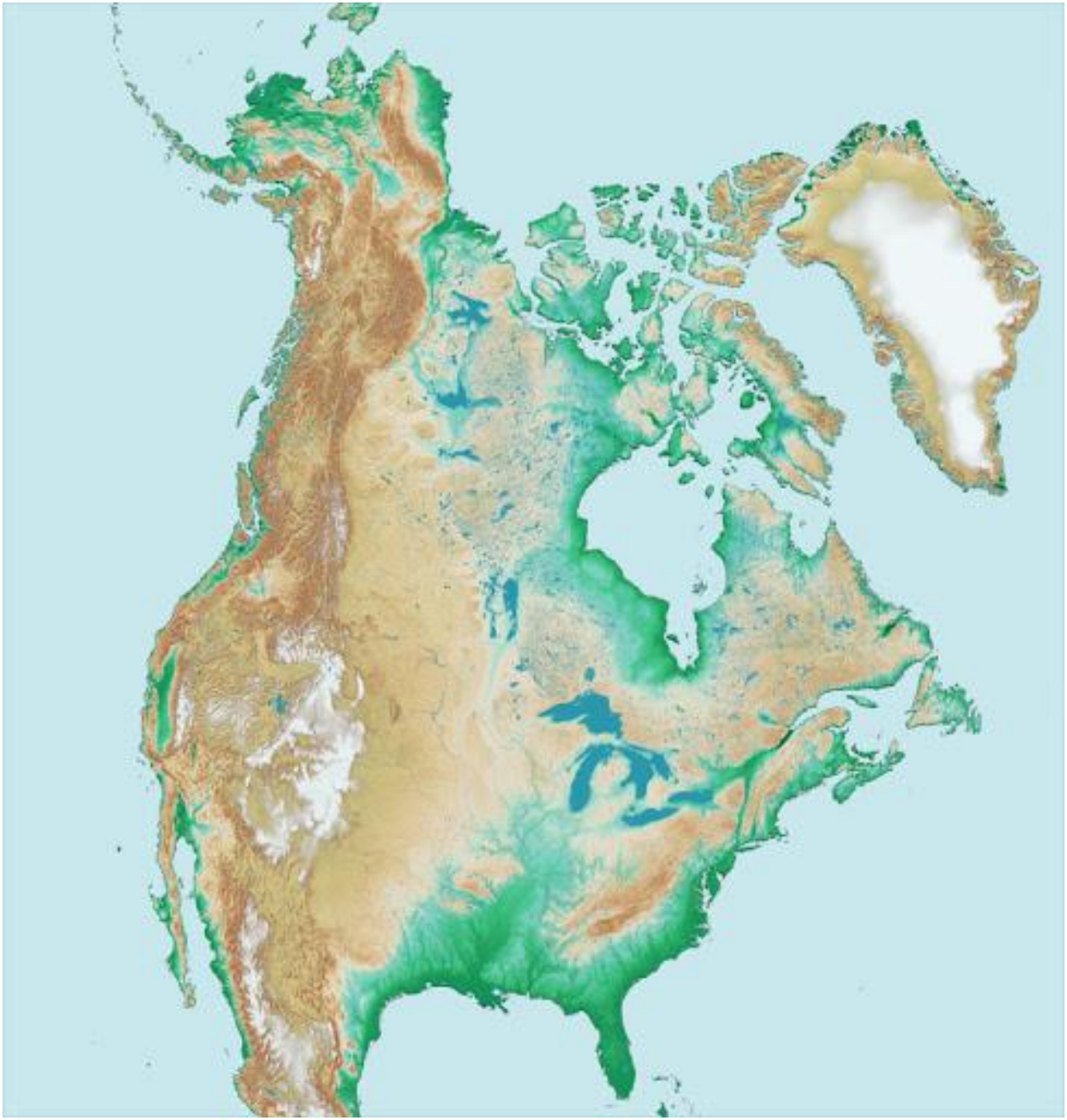
elevation values (usually) in metres



Grayscale is used to store/display elevation data for analysis/viewing – do NOT use for map output

Classified hypsometric layer tints

Easy to produce and modify

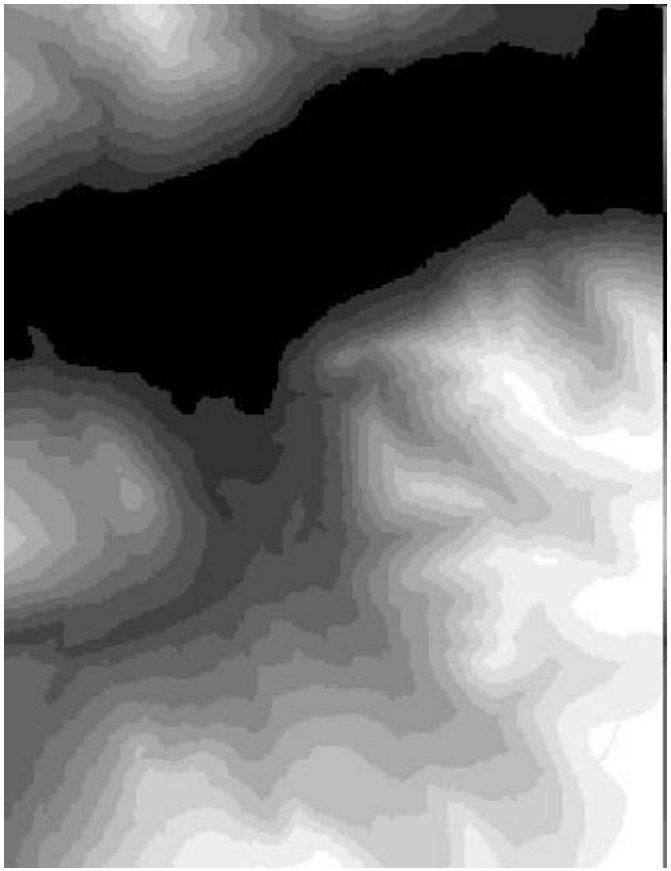


As the crow flies
cARTography, ON
(Canadian Geographic)

6. Shaded relief (hillshade)

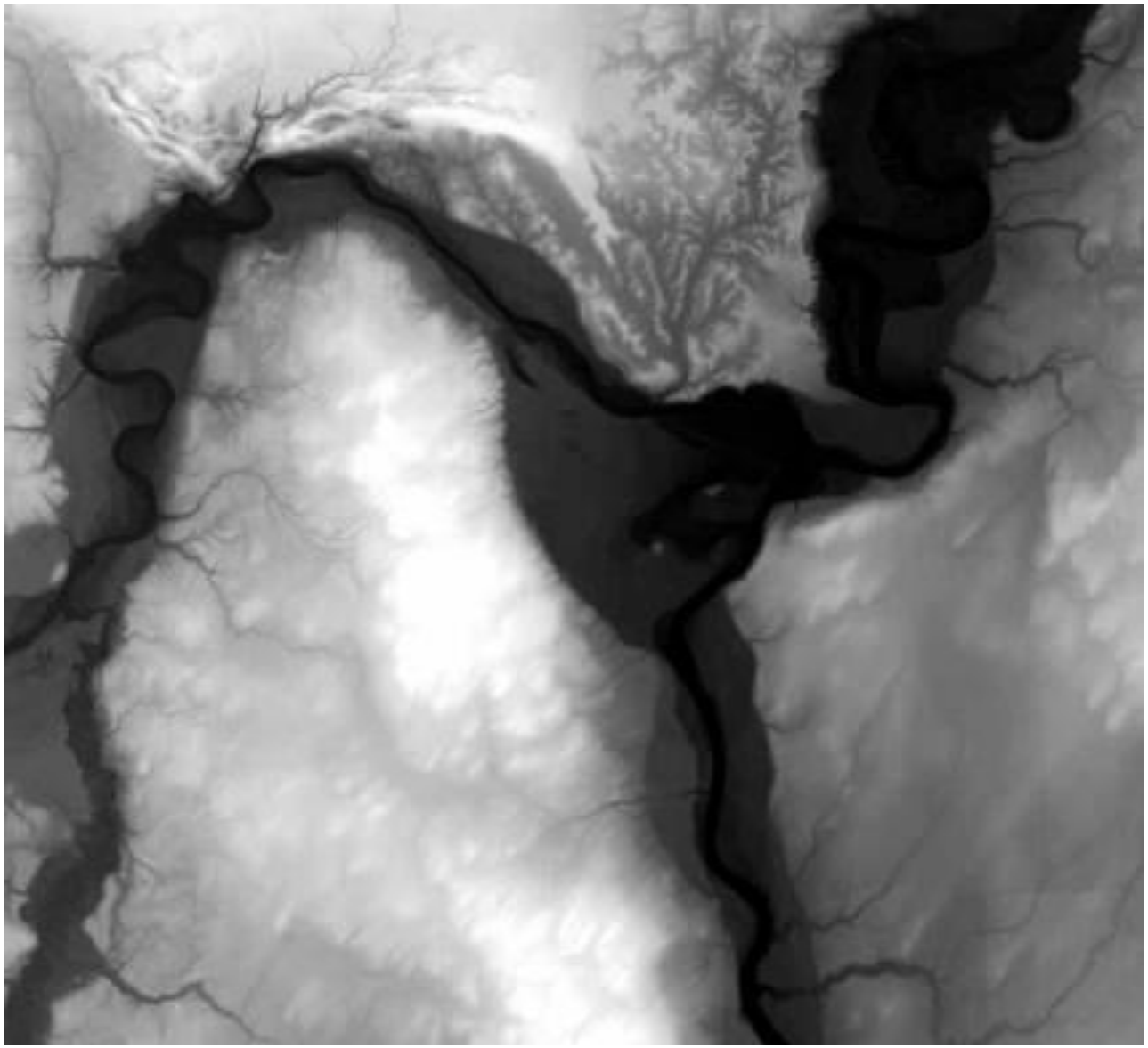
Analogue method: photos -> contours -> sketch shaded relief
Digital method: digital image -> DEM -> shaded relief

Air Photo - DEM - Shaded relief



Brighter = higher

Brighter = facing NW

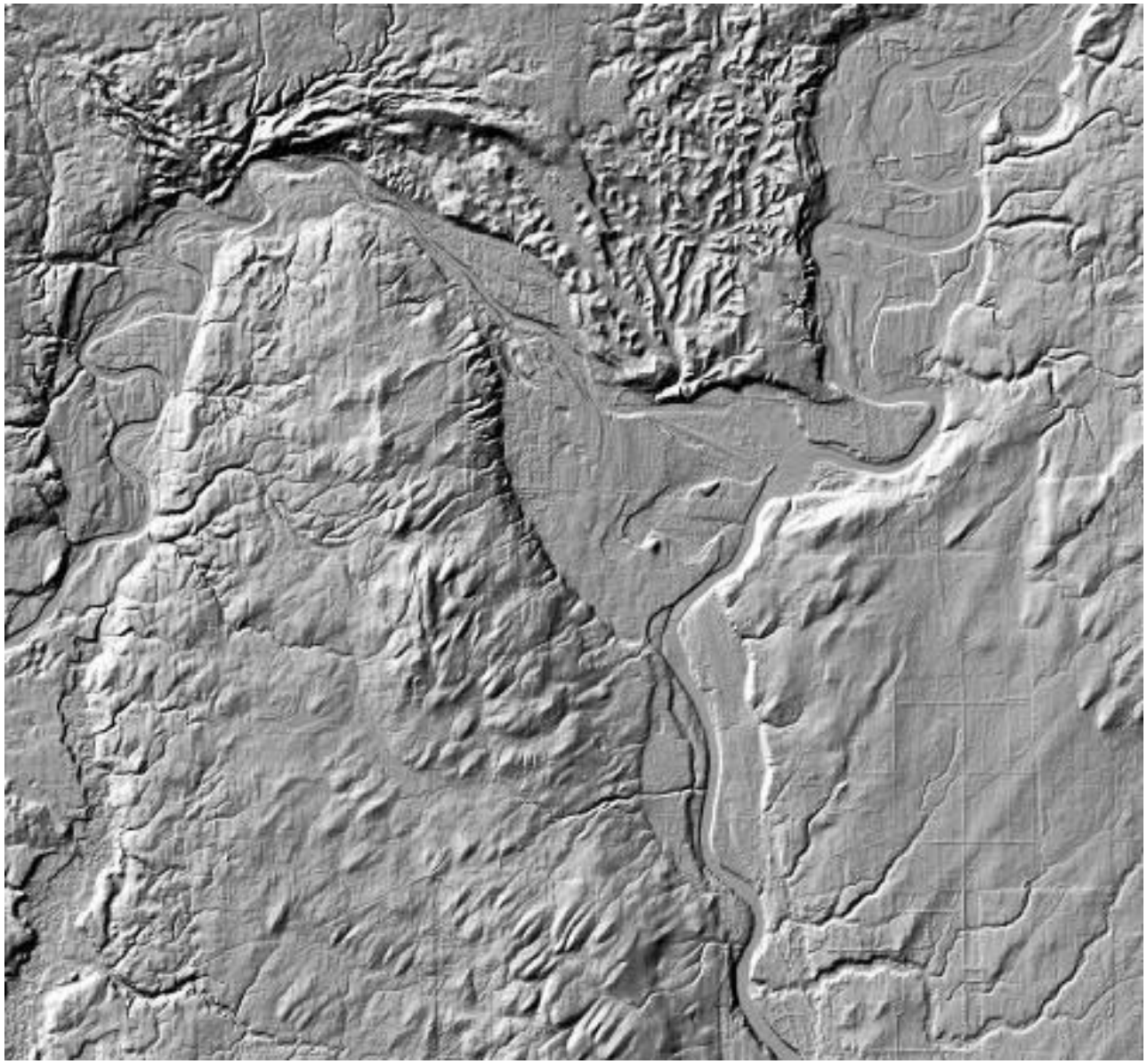


The DEM is used to create tints / hillshade, but is not an effective map layer alone

The pixel values = elevation e.g. 760m

Shaded relief (hillshading) : No need for artistic ability.

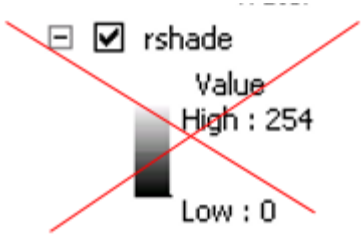
BC TRIM DEM Values = 0-255



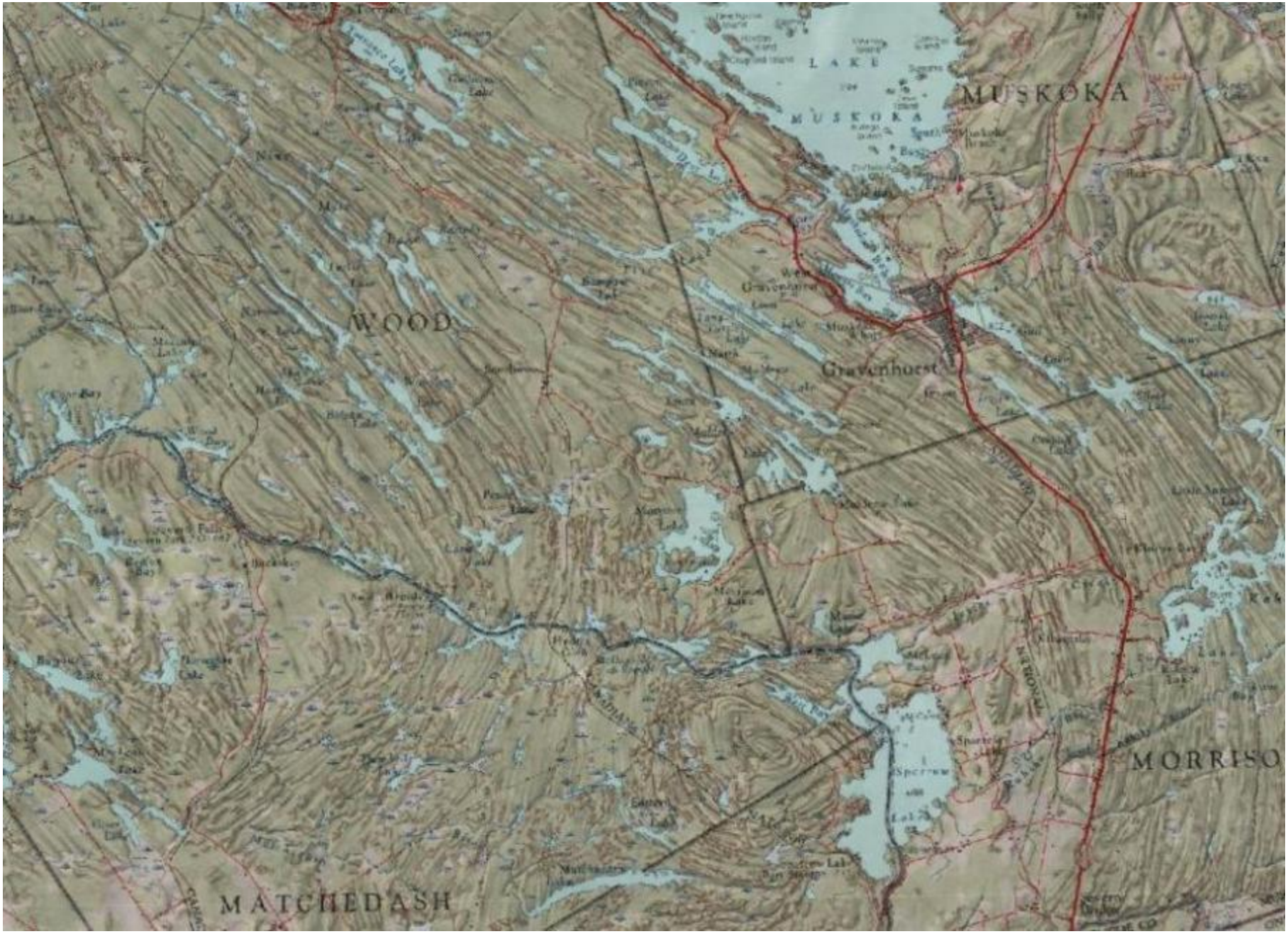
The user selects azimuth / zenith **315 / 45 is** standard to match NW light source.

NEVER show hillshade layer in legend

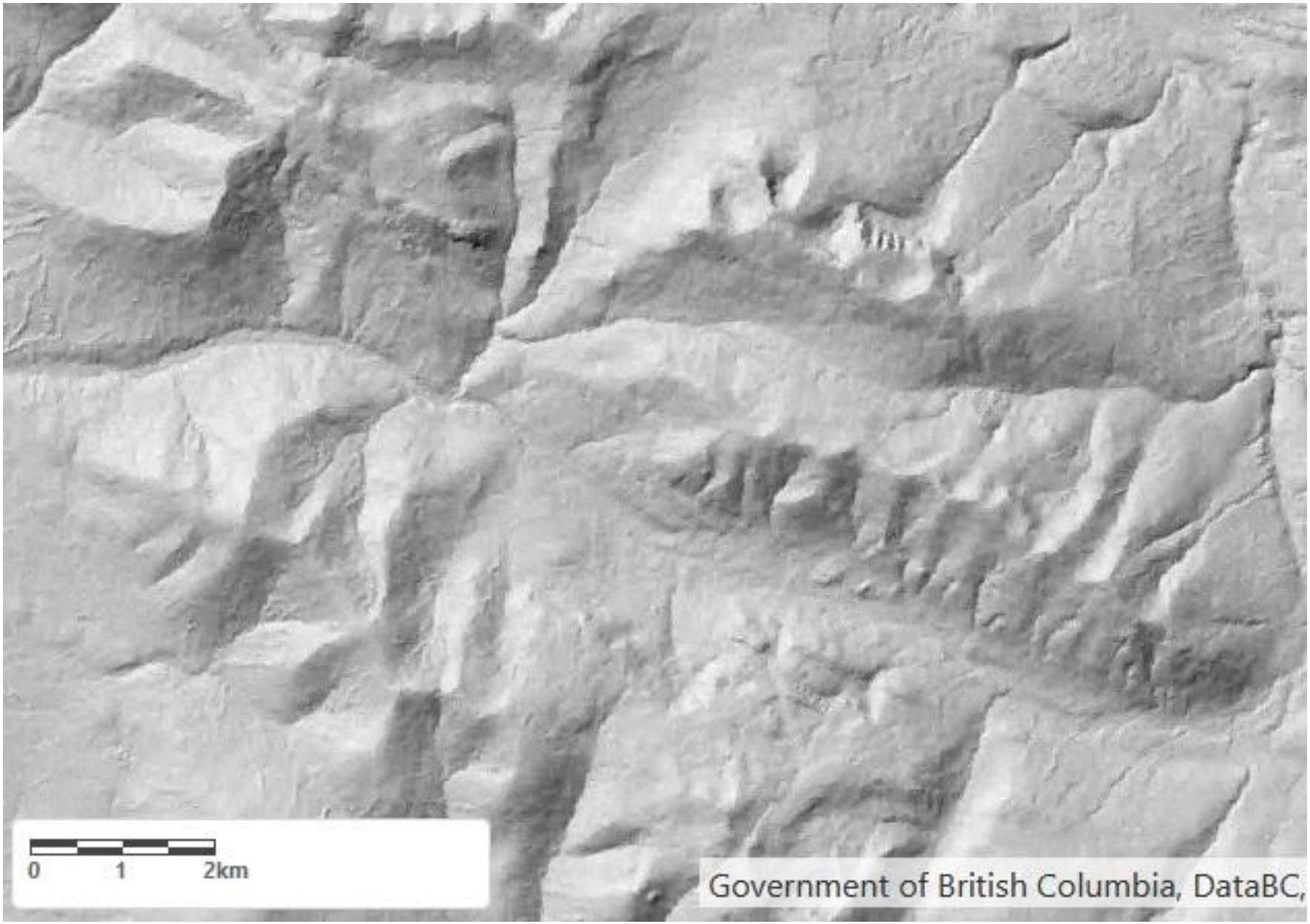
… the numbers are meaningless



Manual shading: less common -100 hours / square foot (trained specialist)



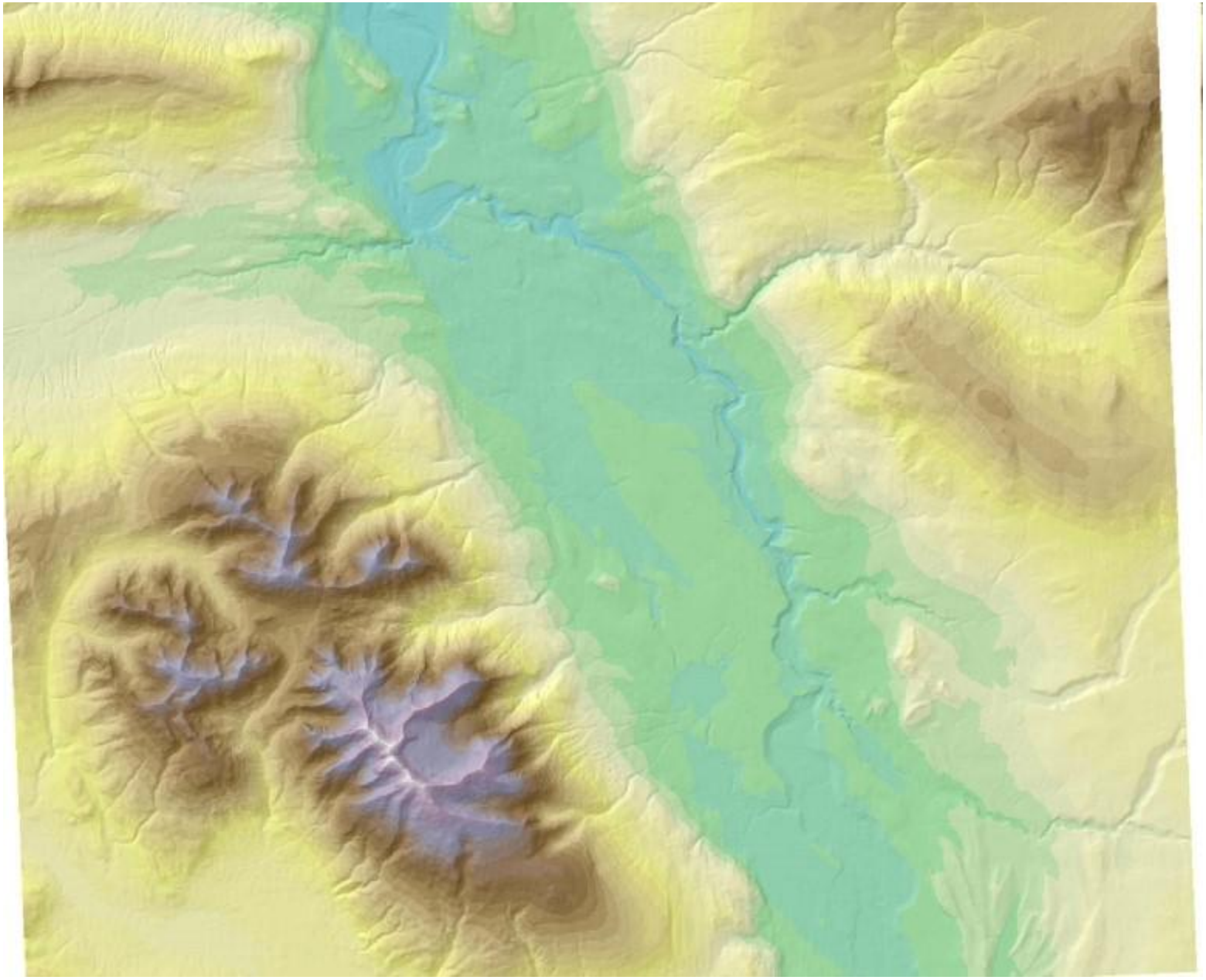
Automated hillshading – an easy software option, usually with light source in NW



BC iMap: https://maps.gov.bc.ca/ess/hm/imap4m

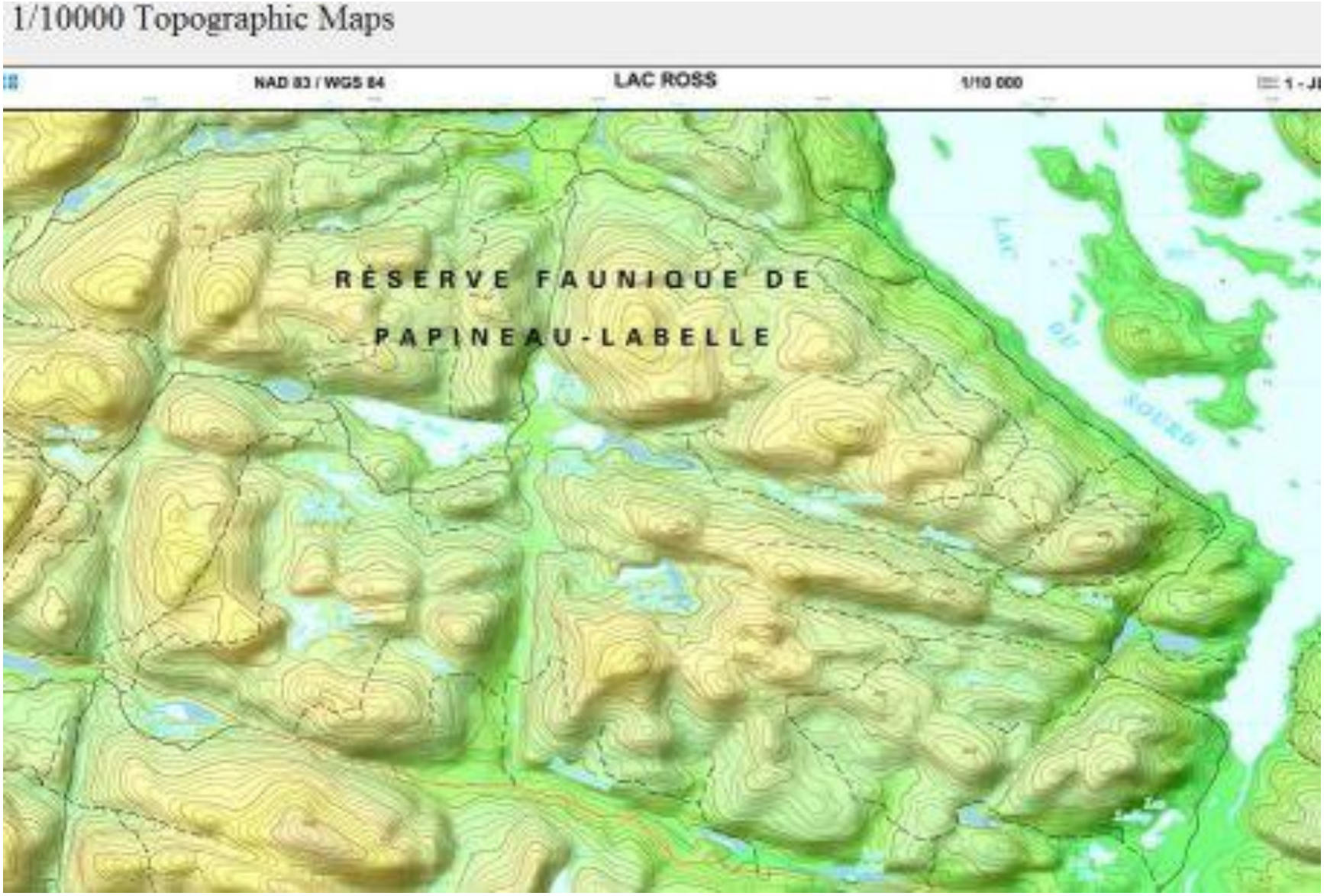
Using software transparency option to combine shading and tints

Routine GIS option



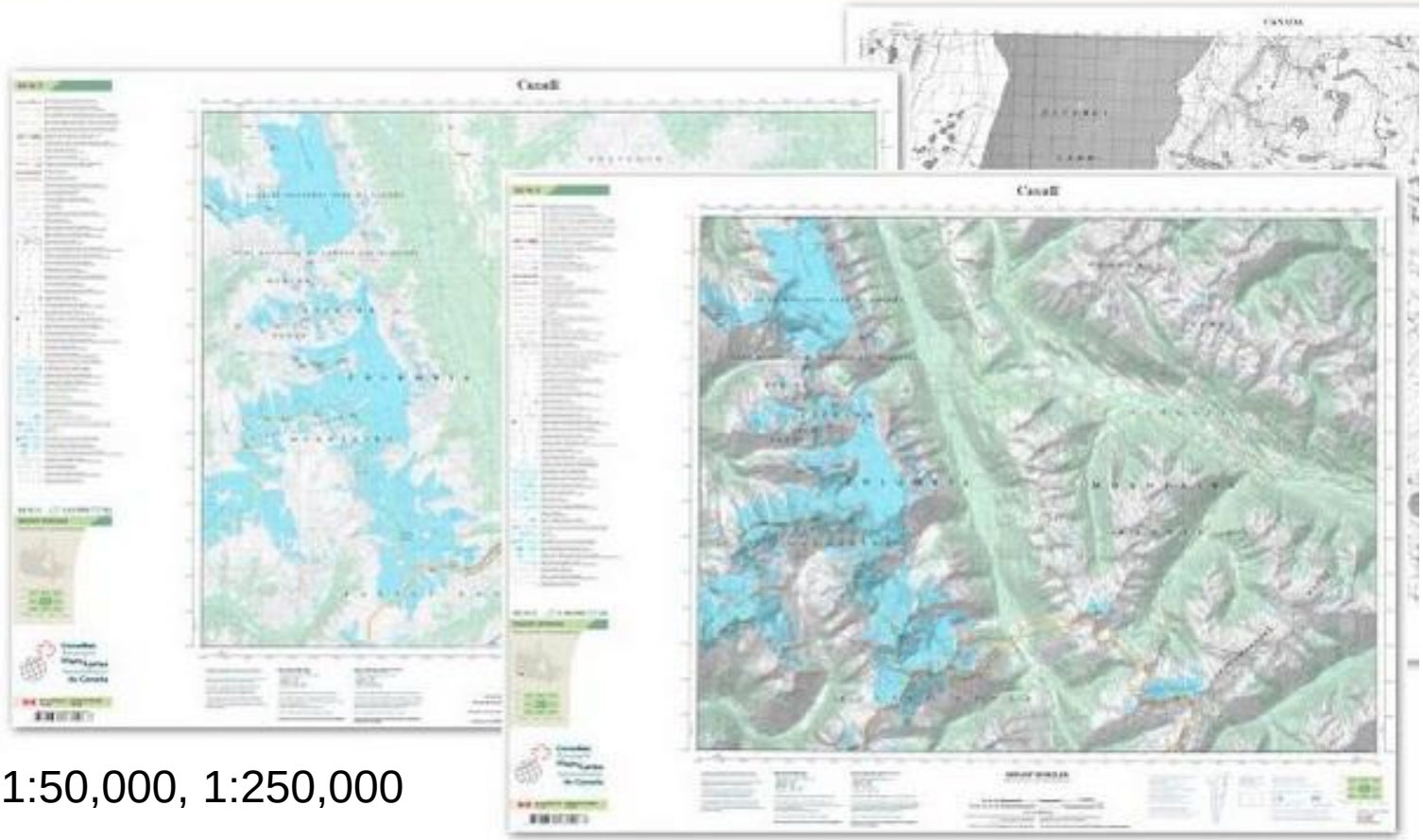
Shaded relief (hillshading) plus elevation tints

JLC Geomatique – addition of shaded relief



Standard topographic map PLUS hillshading – available for <u>all</u> Canada NTS maps: easier visualisation of the landscape
http://gotrekkers.com

HOME | RETURN POLICY | ABOUT GOTREKKERS | HELP | CONTACT US

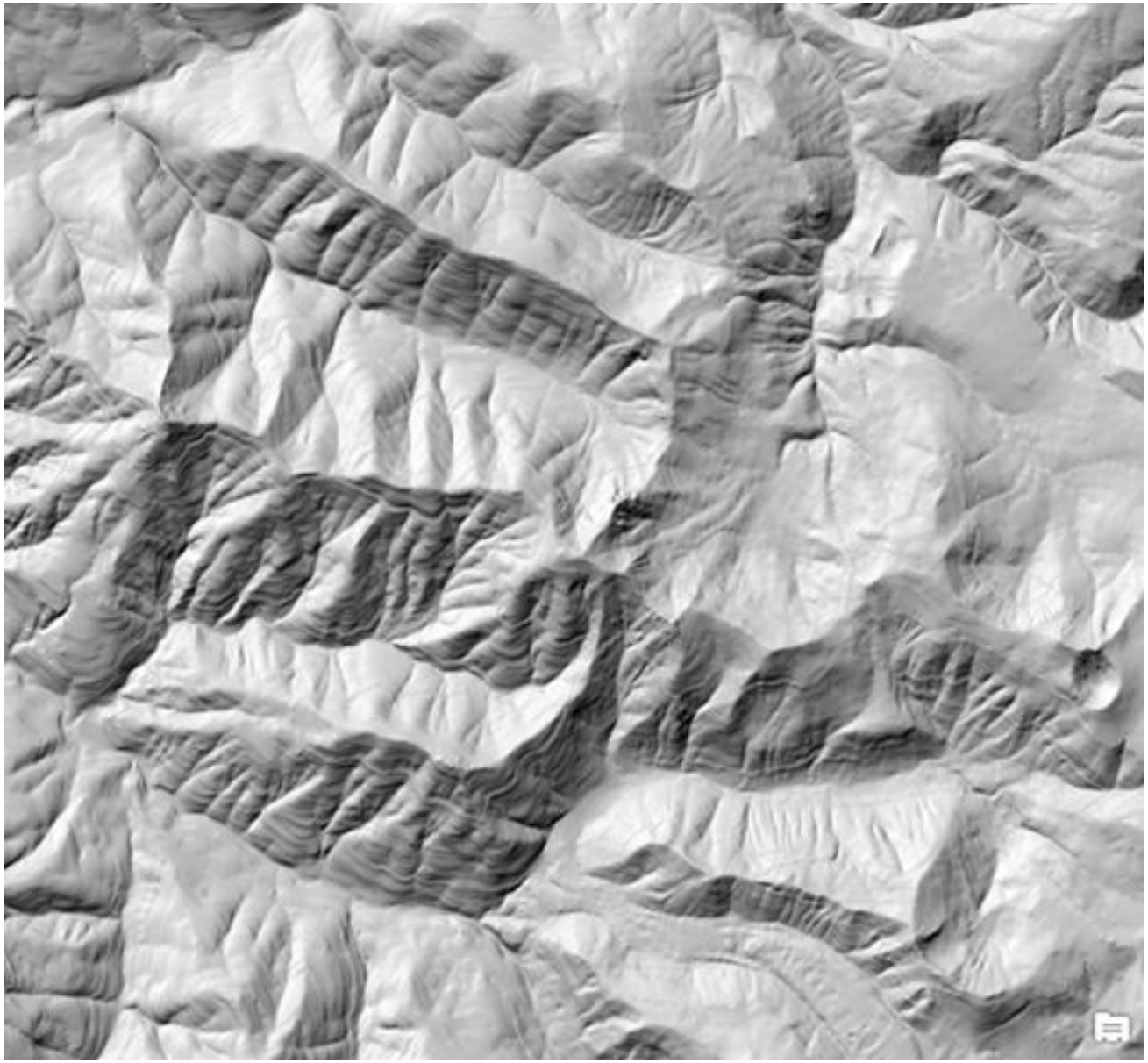


1:50,000, 1:250,000

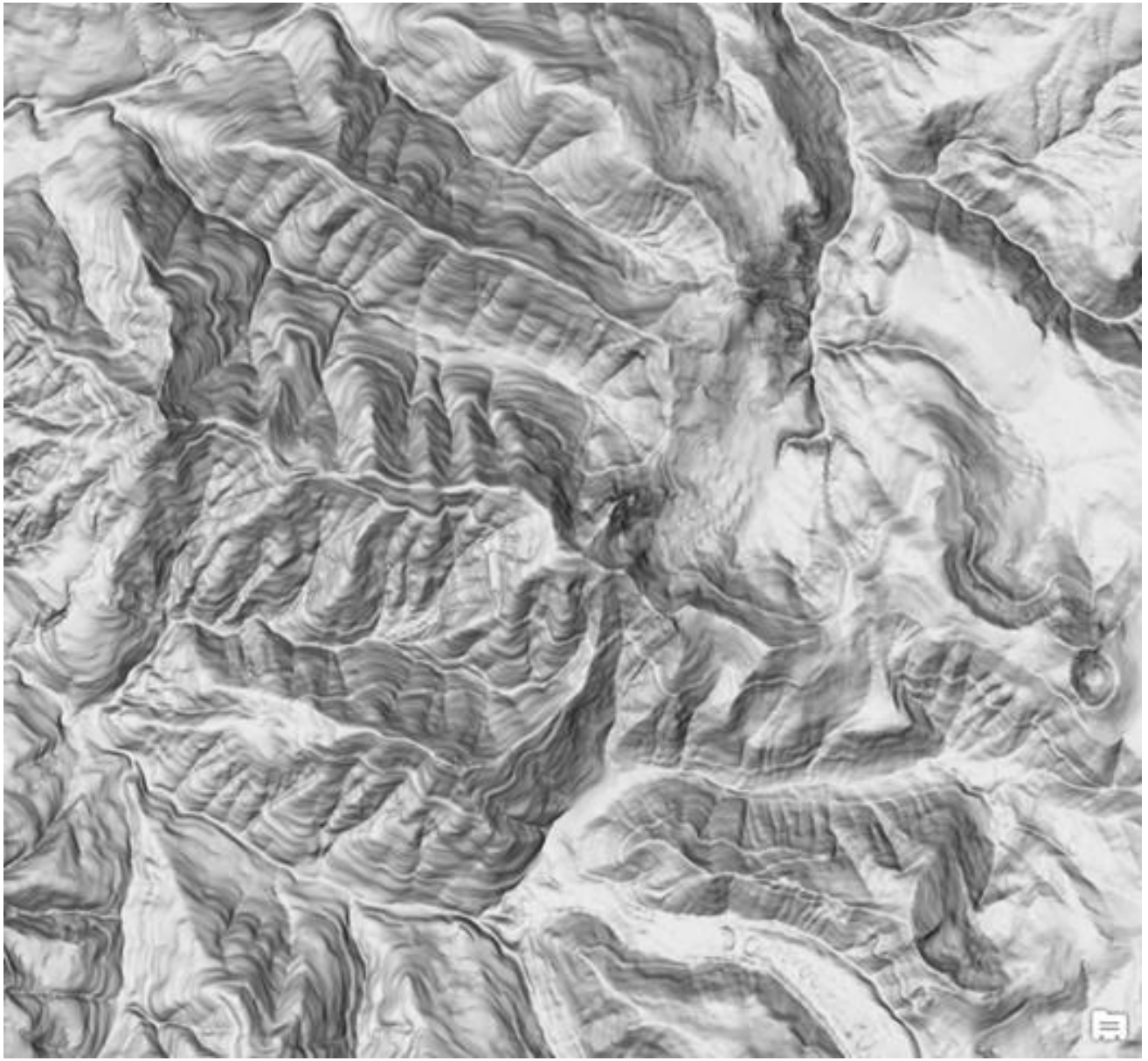
ArcGIS: traditional shading – NW light source

Issues with ‘manual’ approach with fixed light source:

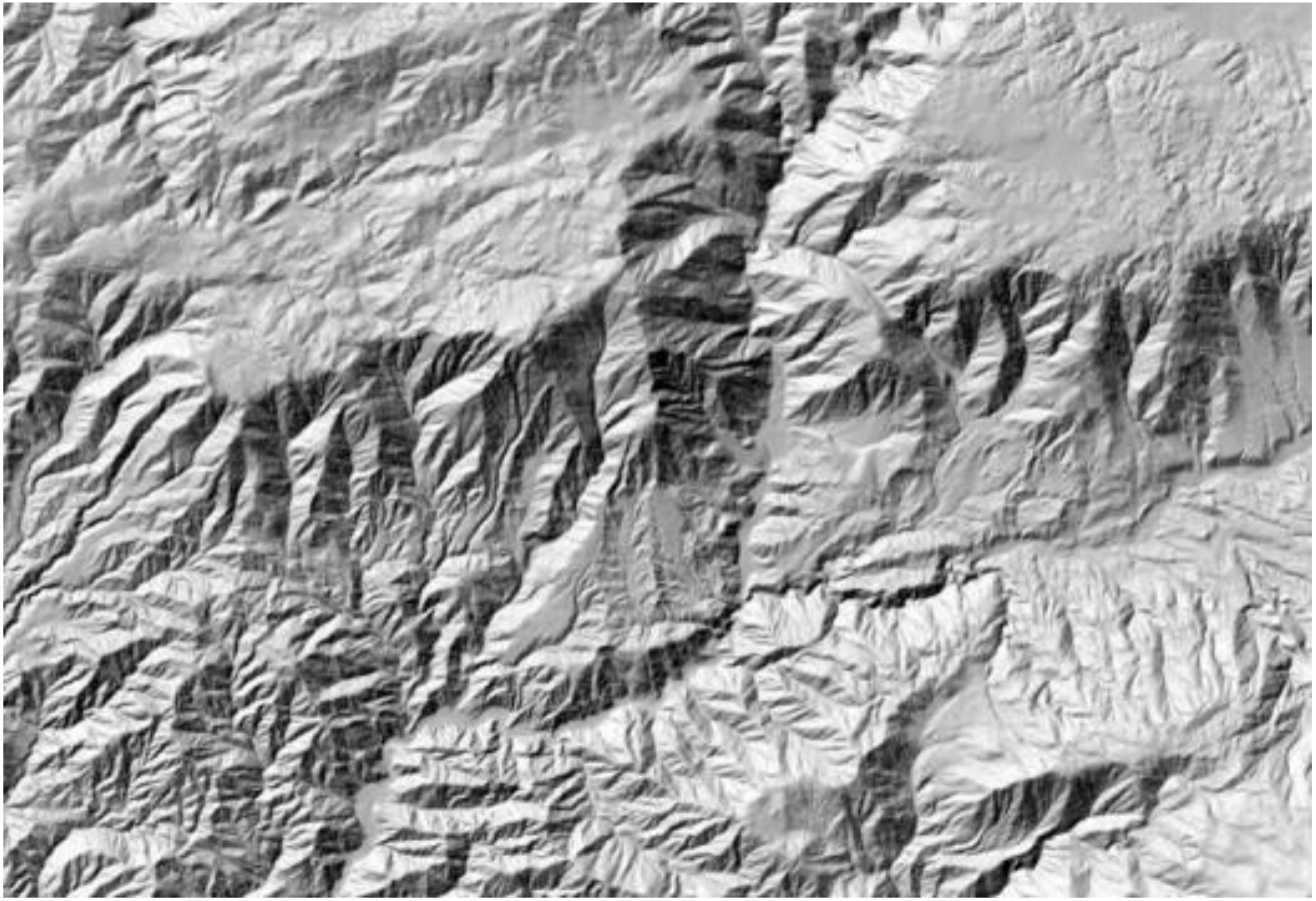
- hills/valleys running NW-SE (= low contrast)



ArcGIS: multi-directional shading



ArcGIS: traditional shading



ArcGIS: multi-directional shading

7. Tanaka relief contours

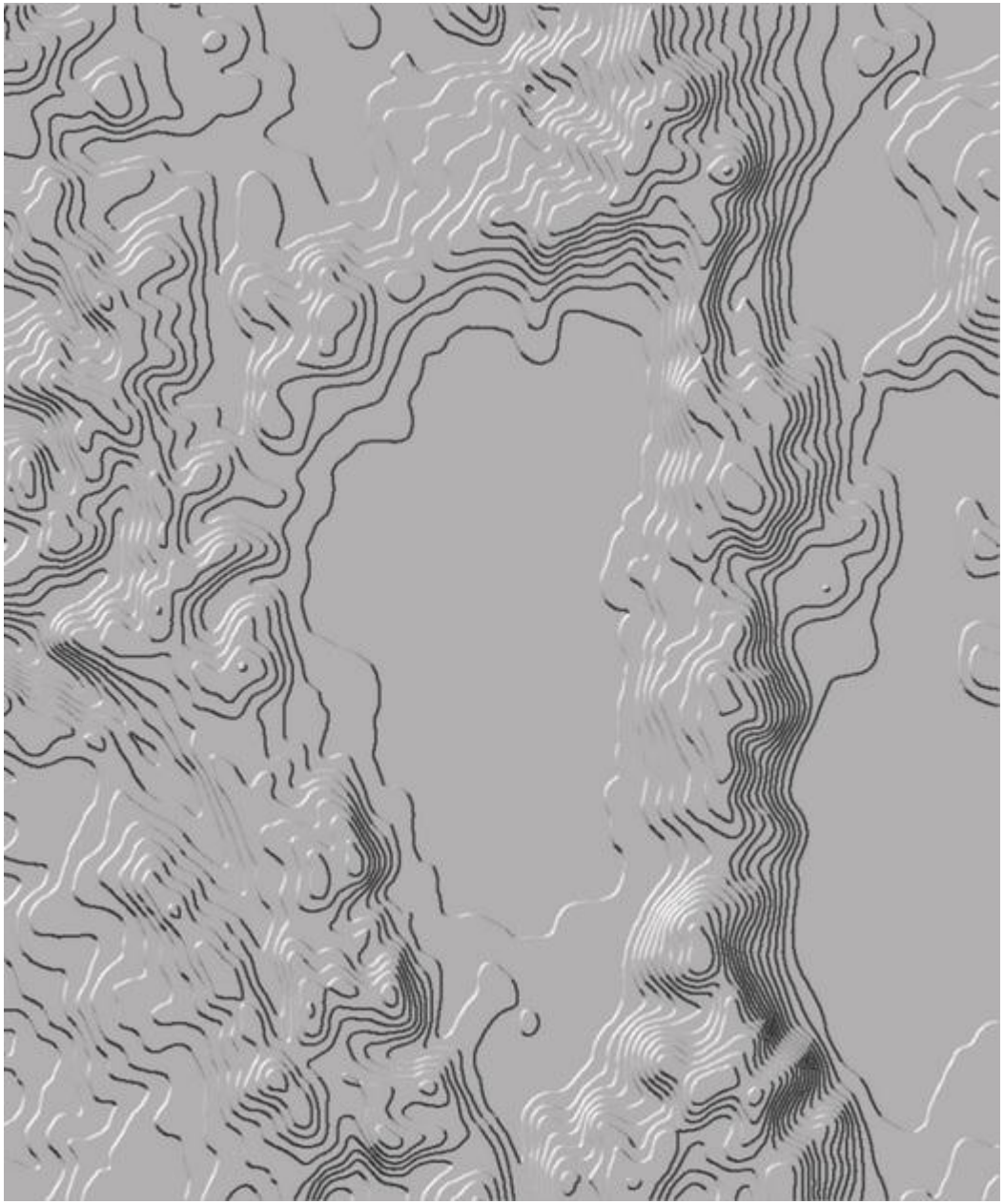
not a common software option

ArcGIS Terrain Tools

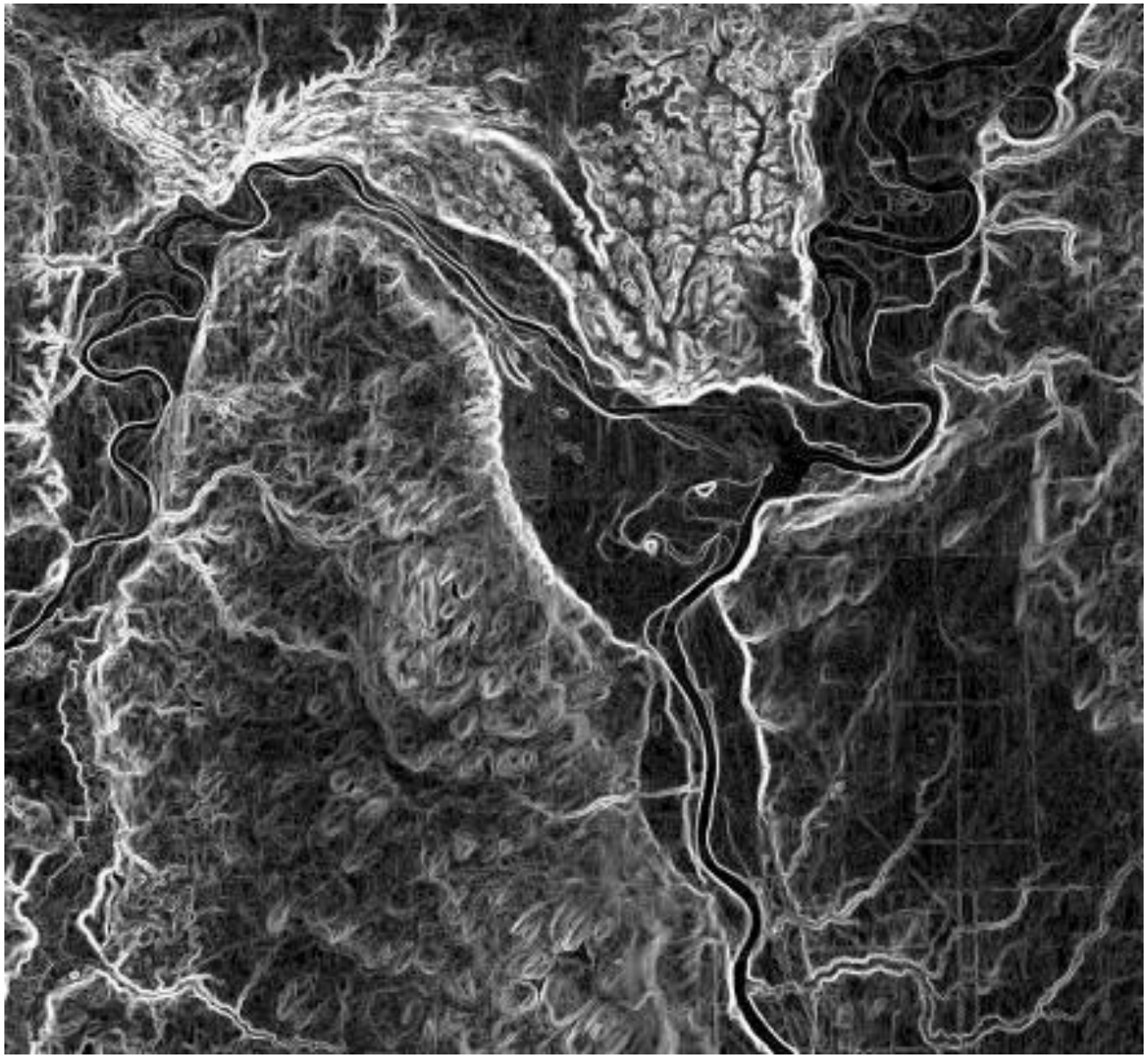
2016

includes Hachures

https://www.sigterritoires.fr/index.php/en/terrain-tools-for-arcgis-10-3-and-arcgis-pro



8. **DEM layers: Slope** – used in GIS analysis, rarely as a map layer



Values = 0-90 (degrees) or %

(0-> ∞)

Bright = steep

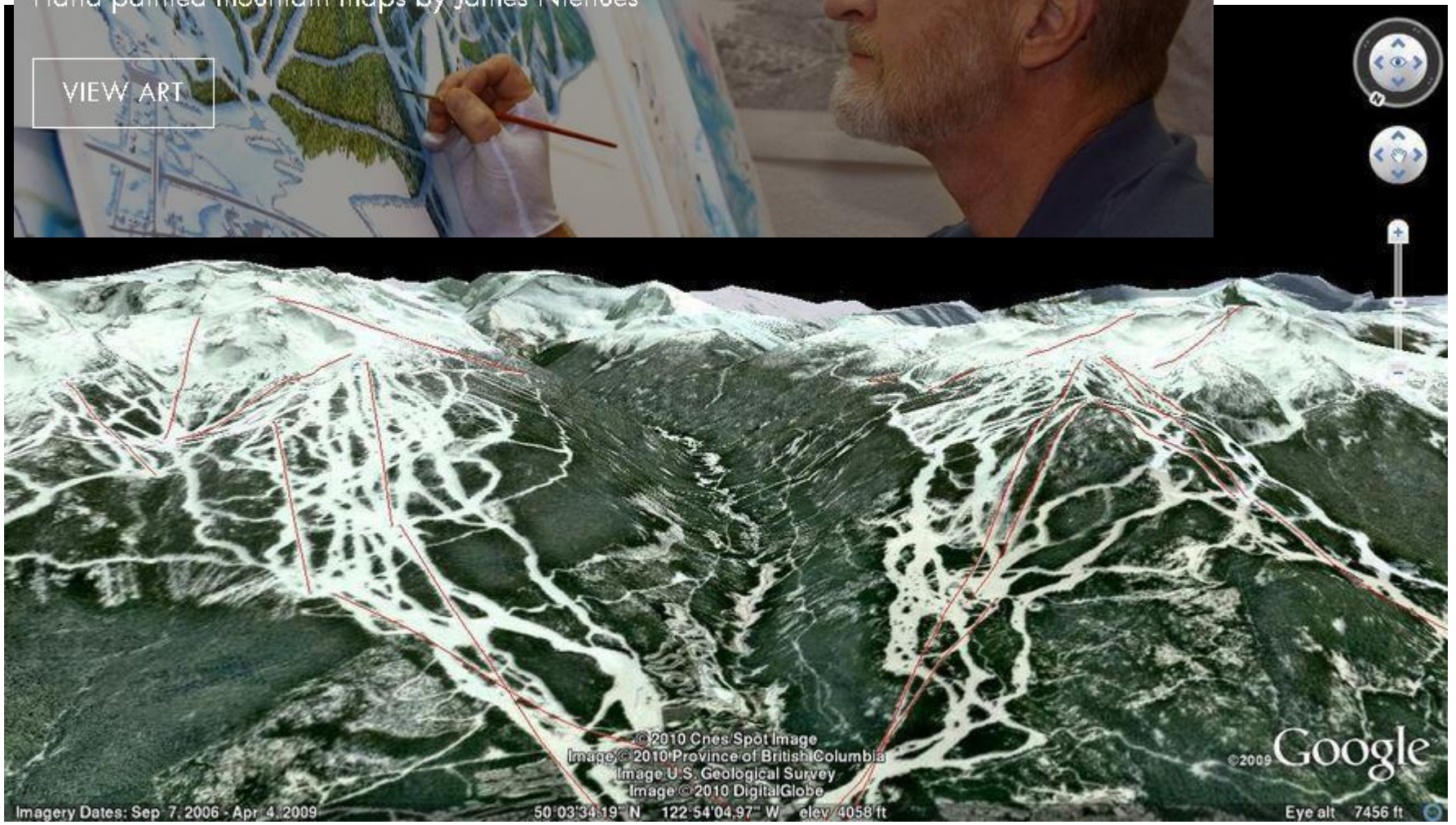
(aspect is not a factor)

Dark = flat

9. (2.5D) **perspectives** (and flythroughs) – Google Earth, ArcGIS

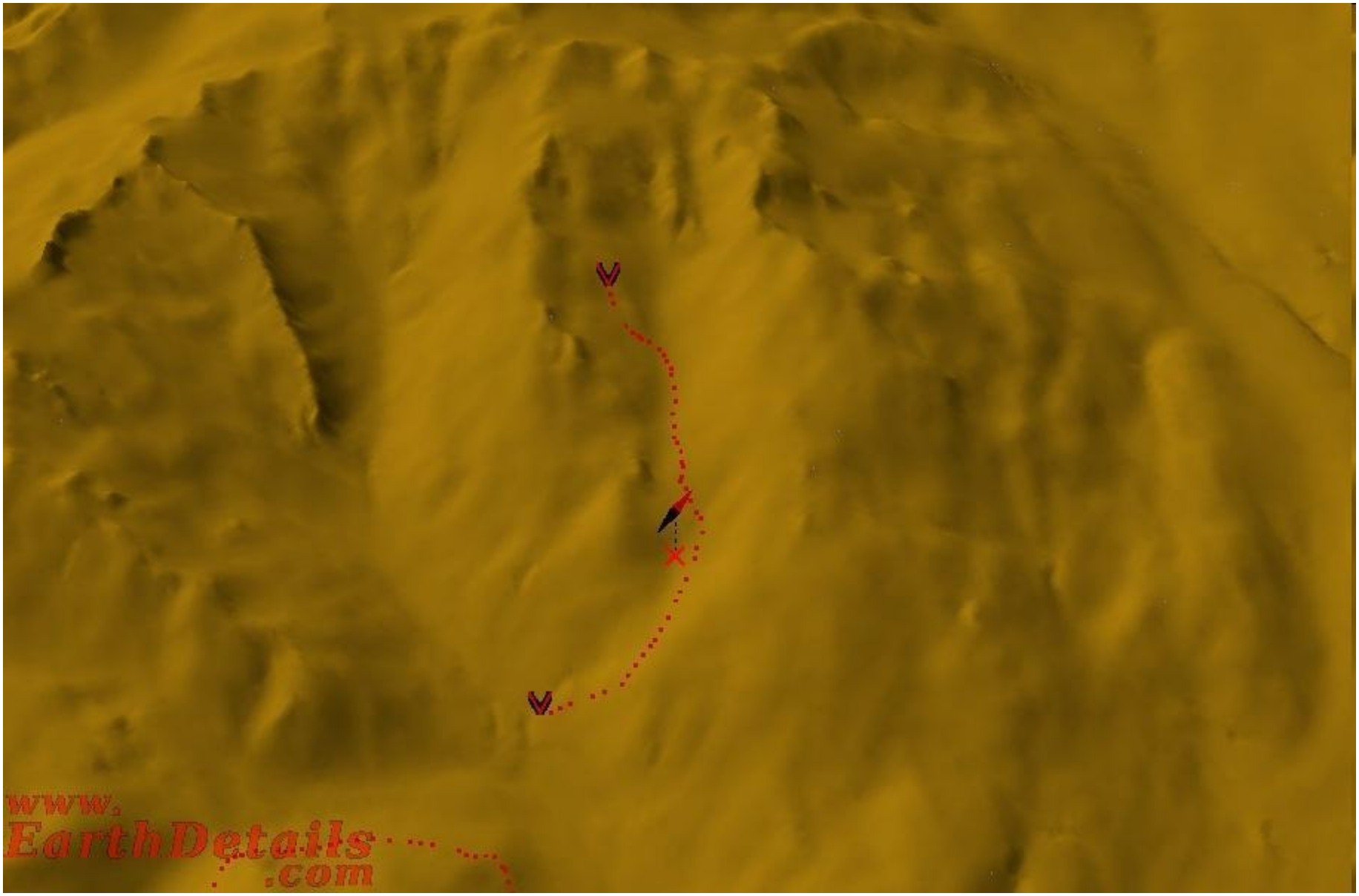
Plus "fly-through" animations

Hand-drawn

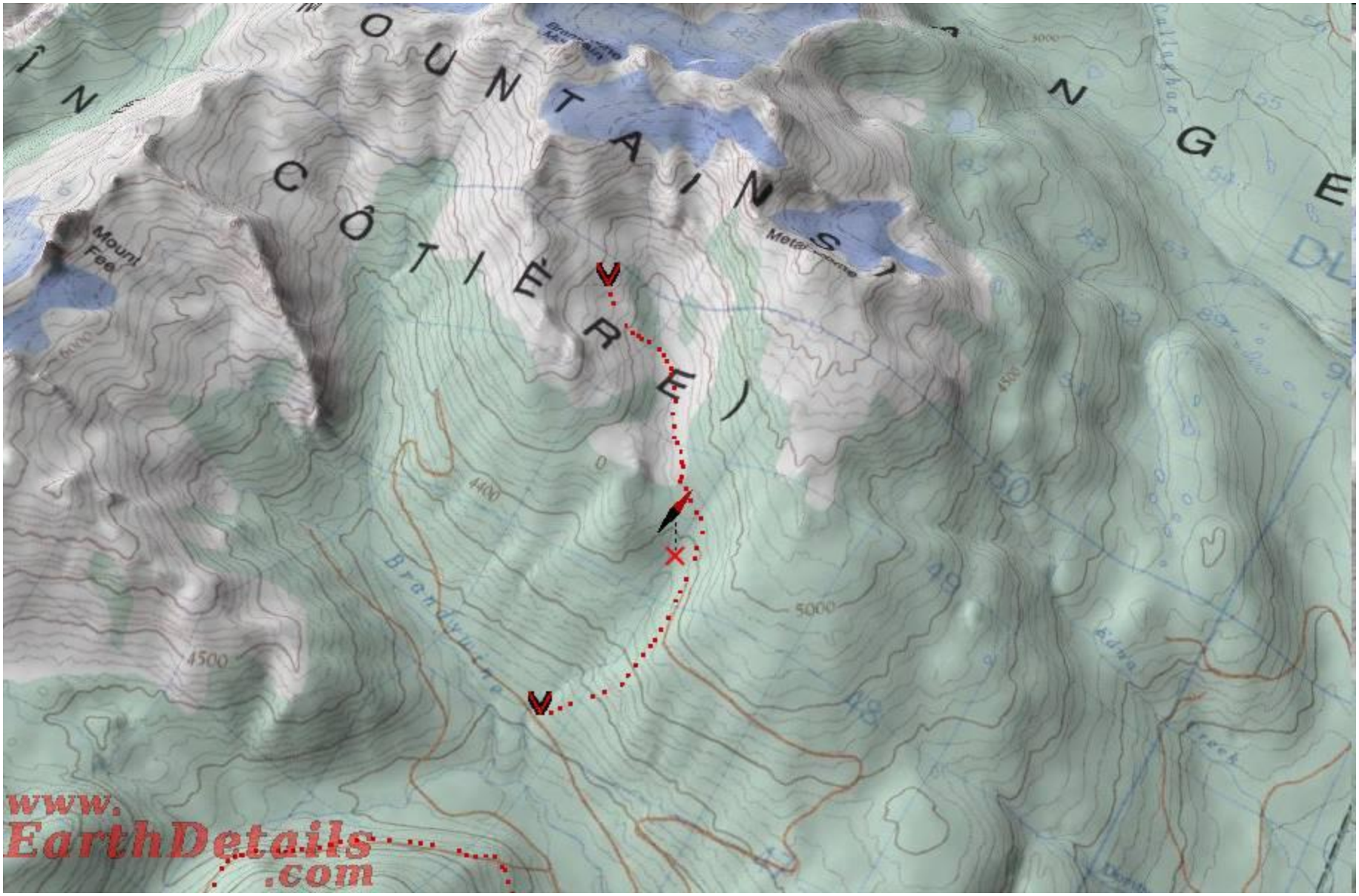


Google Earth as Perspectives for ski hills e.g. Whistler-Blackcomb

9. **Perspectives –** draping a surface e.g. vectors



Whistler – Brandywine Meadows – with 'draped' NTS map

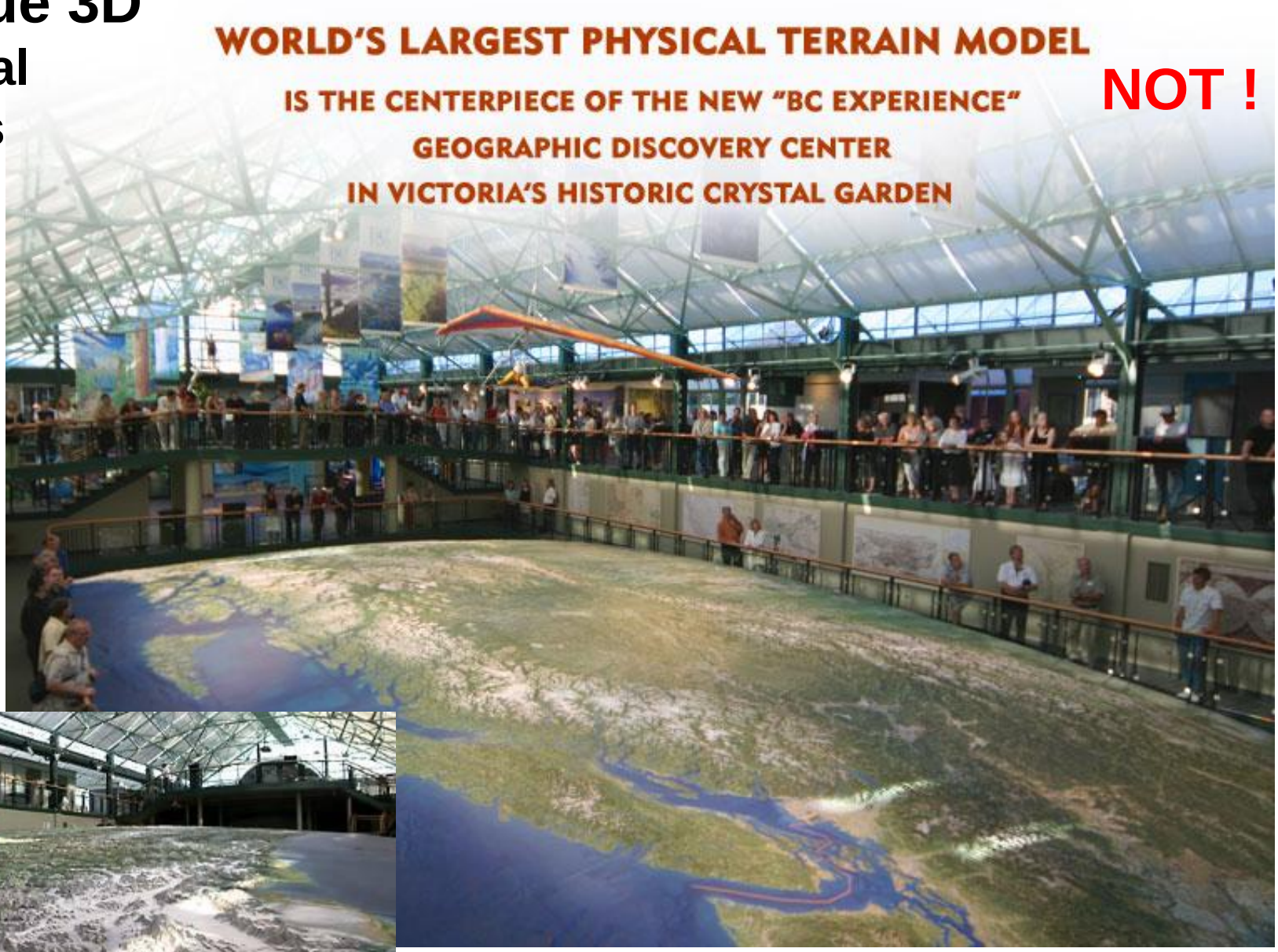


10. True 3D physical models

http://www.stm-usa.com/bc.htm

-40 x 74’ 1:99,000)

-Solid Terrain Modelling Cut by laser



Note: Jack Challenger’s BC wood map is 25 x 25m
Manually carved / created 1945-52, now in storage

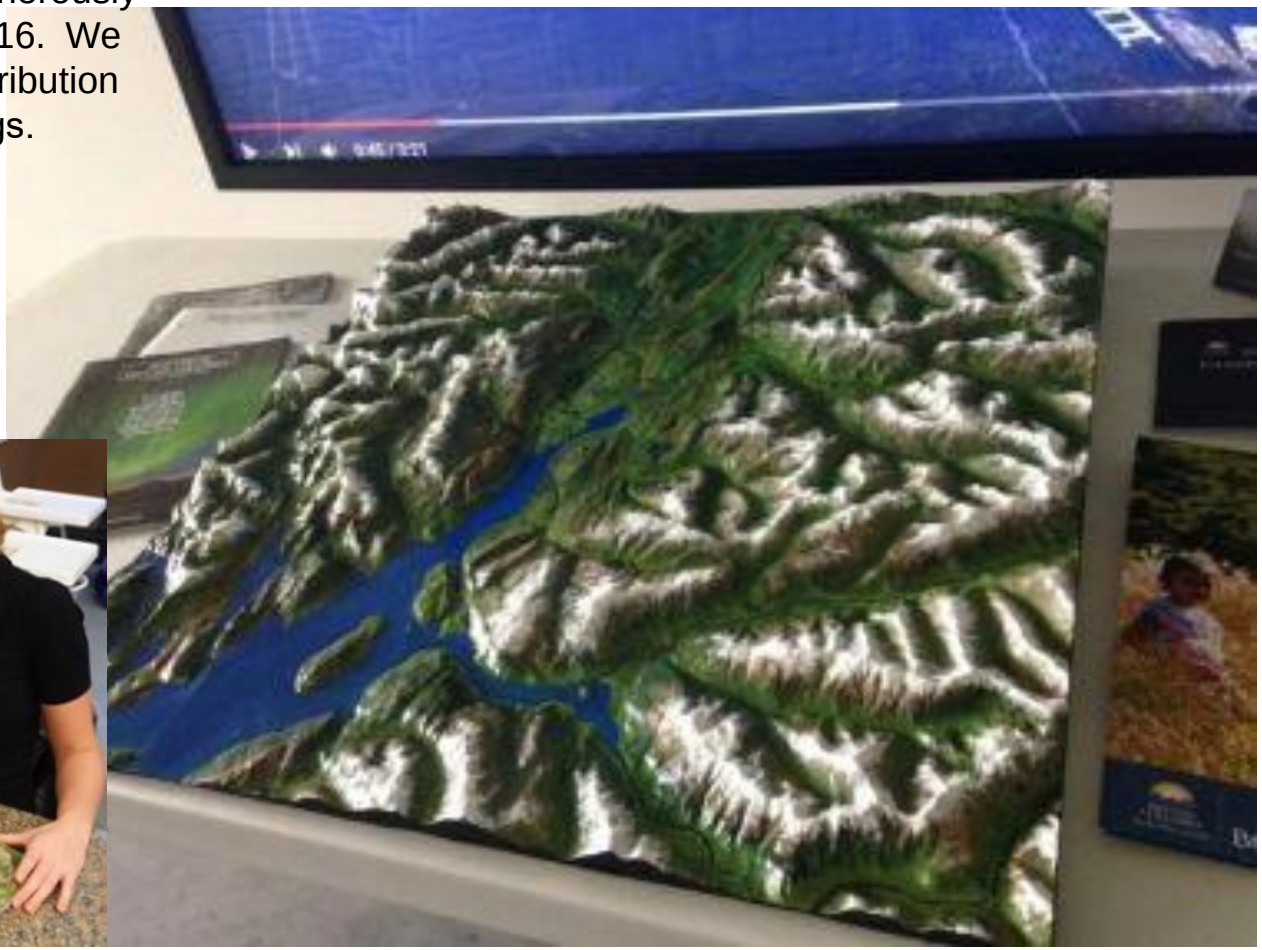
3d printer, Filaprint, Tumbler Ridge

~~http://www.filaprint.ca~~ X

Tumbler Ridge woman puts the pop in 3D maps

Our local 3d printing company generously gave the library a 3d printer in 2016. We thank Jody for the awesome contribution to the library's technology offerings.

Jody Mitchell



Topographic Lake Map: Maple 12 x 24 $465

https://www.vanhorlicks.com/topographic-lake-map-maple-12-x-24.html

How have DEMs impacted relief depiction ?

- Sugar-loafs and hachures – can be added graphically
- Contours – digitised layer, but a DEM is more useful
- Hypsometric Tints – easily applied colour ramp from DEM
- **Shaded relief (hillshading)** – ***greatest impact (mapping)***
- **'2.5D' perspectives** – ***2nd greatest impact (visualisation)***
- True 3D models – cut by laser, modest change (from manual)