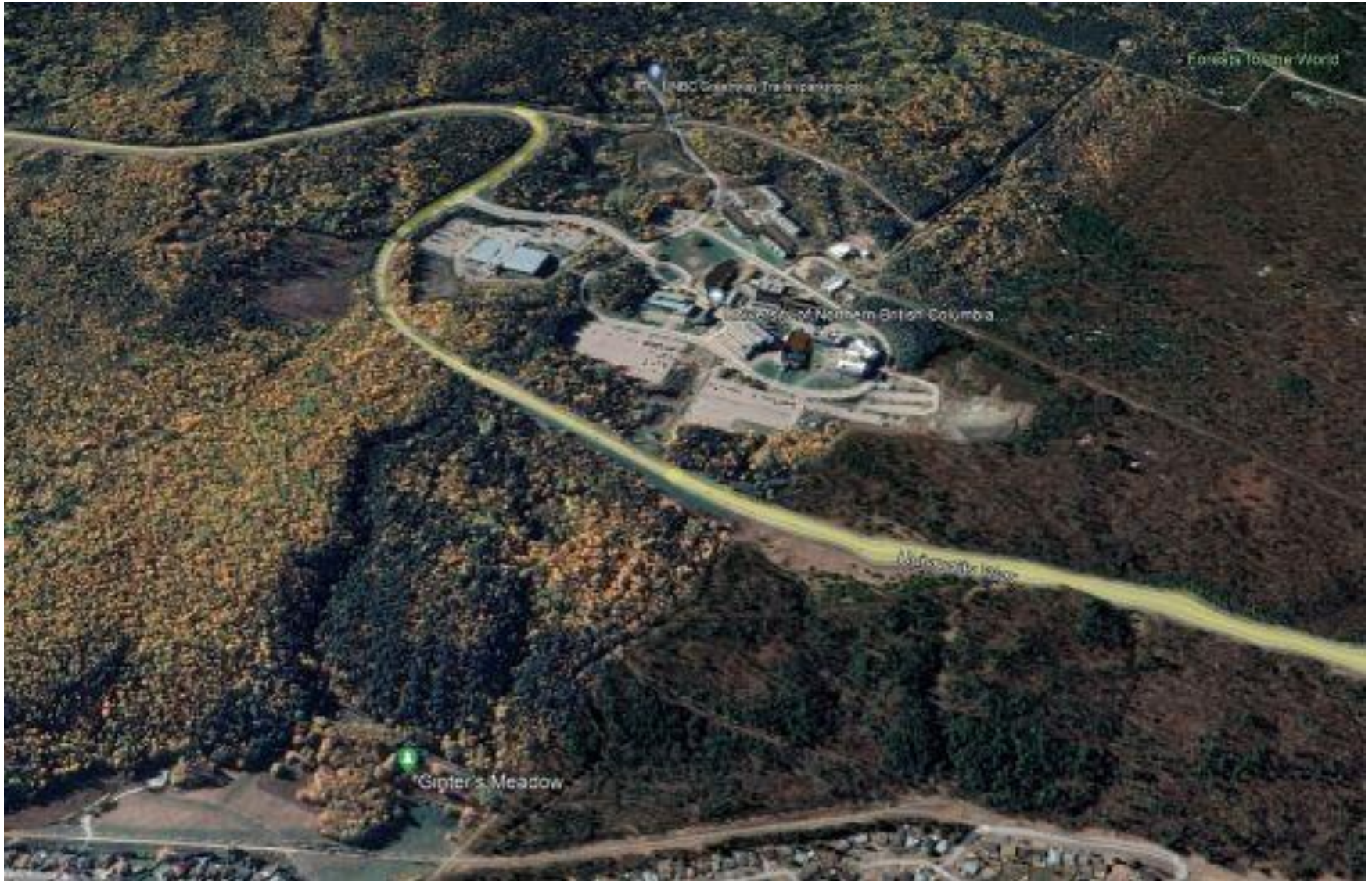
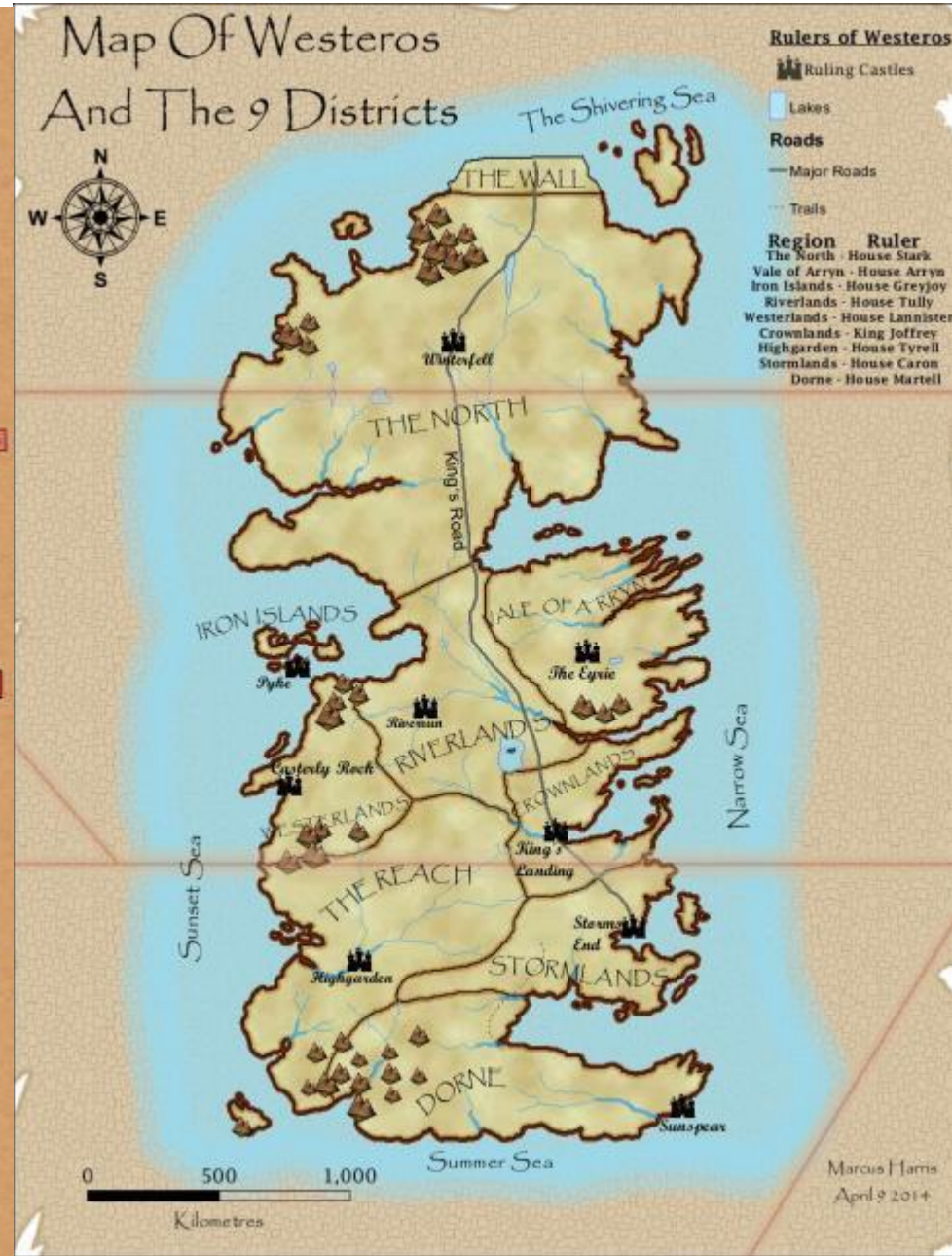
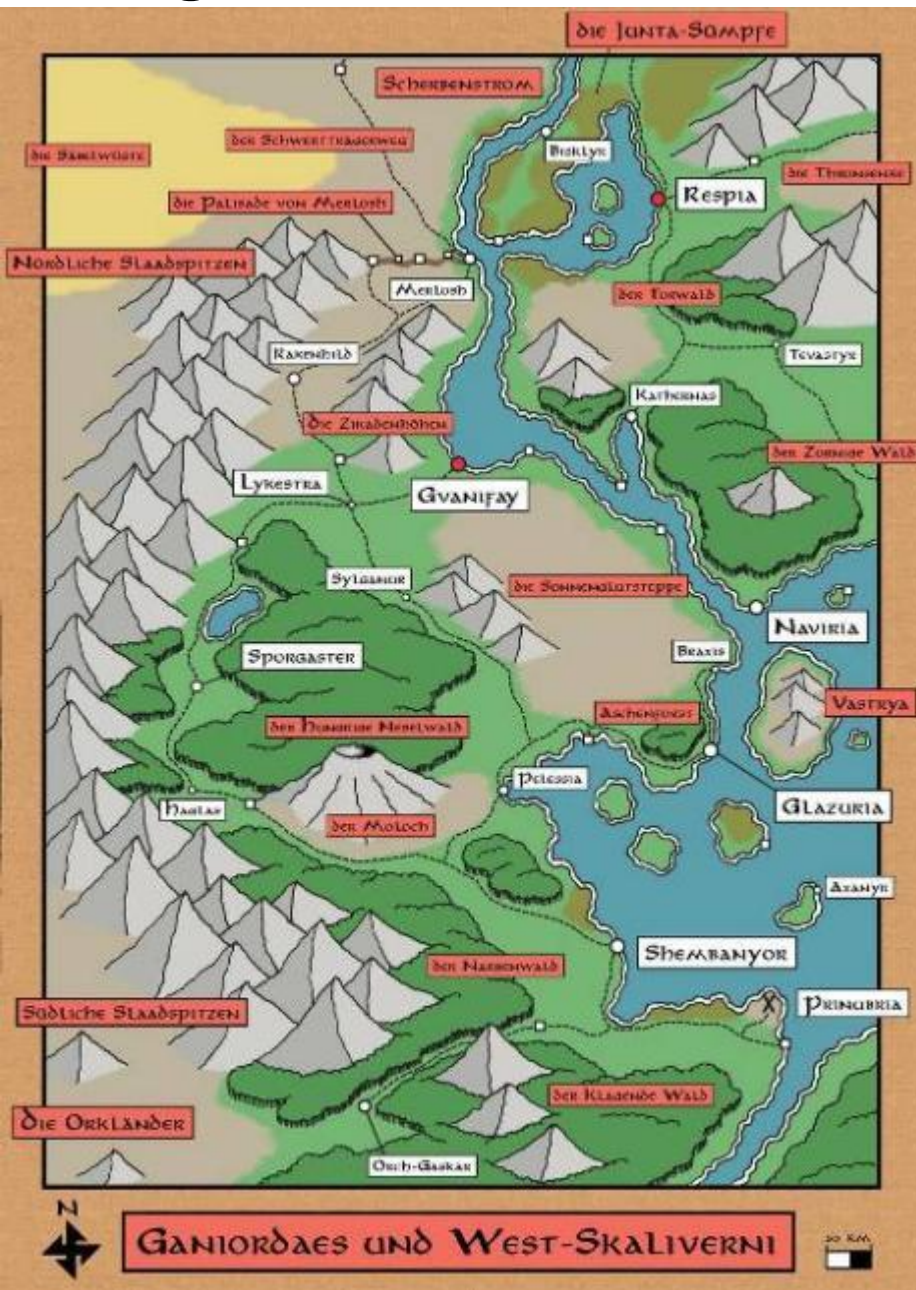


Digital Elevation / Terrain Models DEM / DTM

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 - NOT a common software option

show slope by line thickness and direction

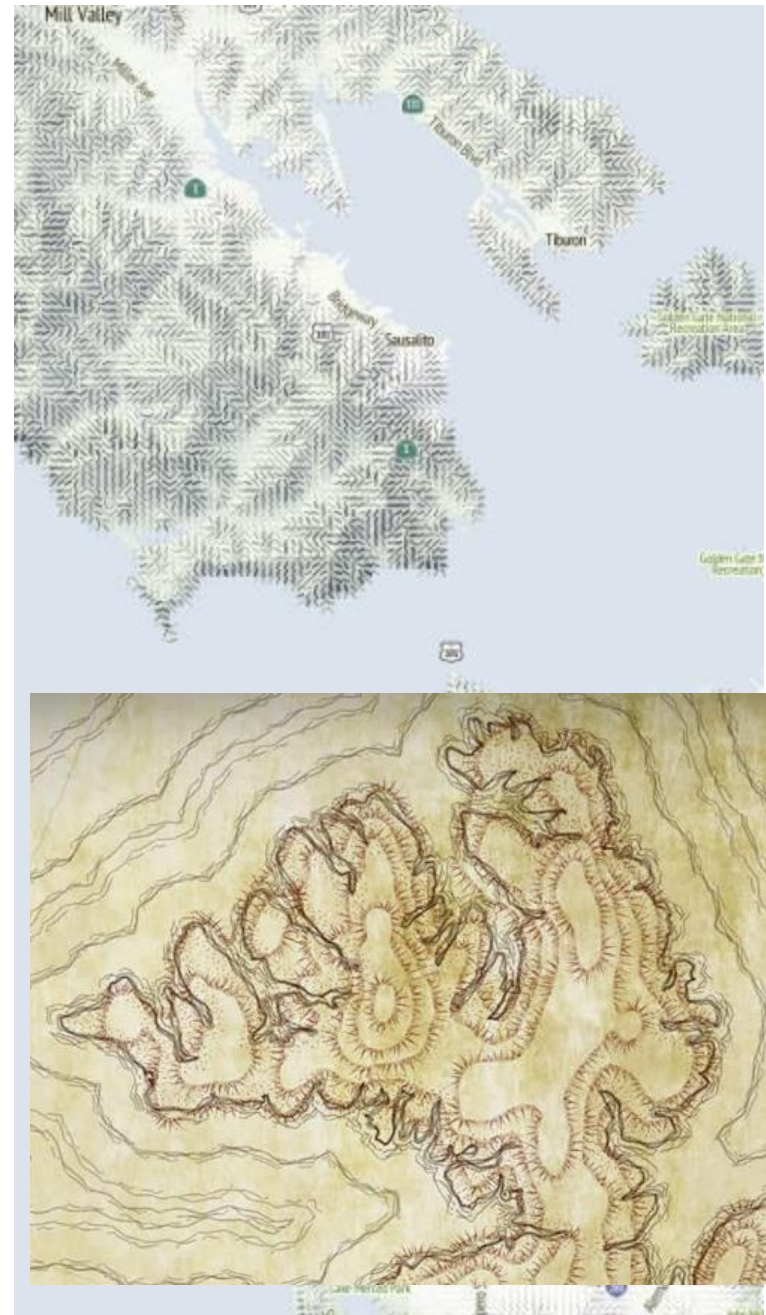
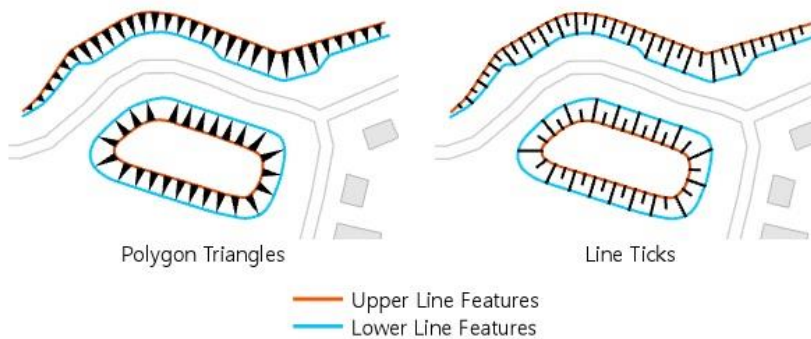
Generate Hachures For Defined Slopes (Cartography)

ArcGIS Pro 3.0 | [Other versions](#) | [Help archive](#)

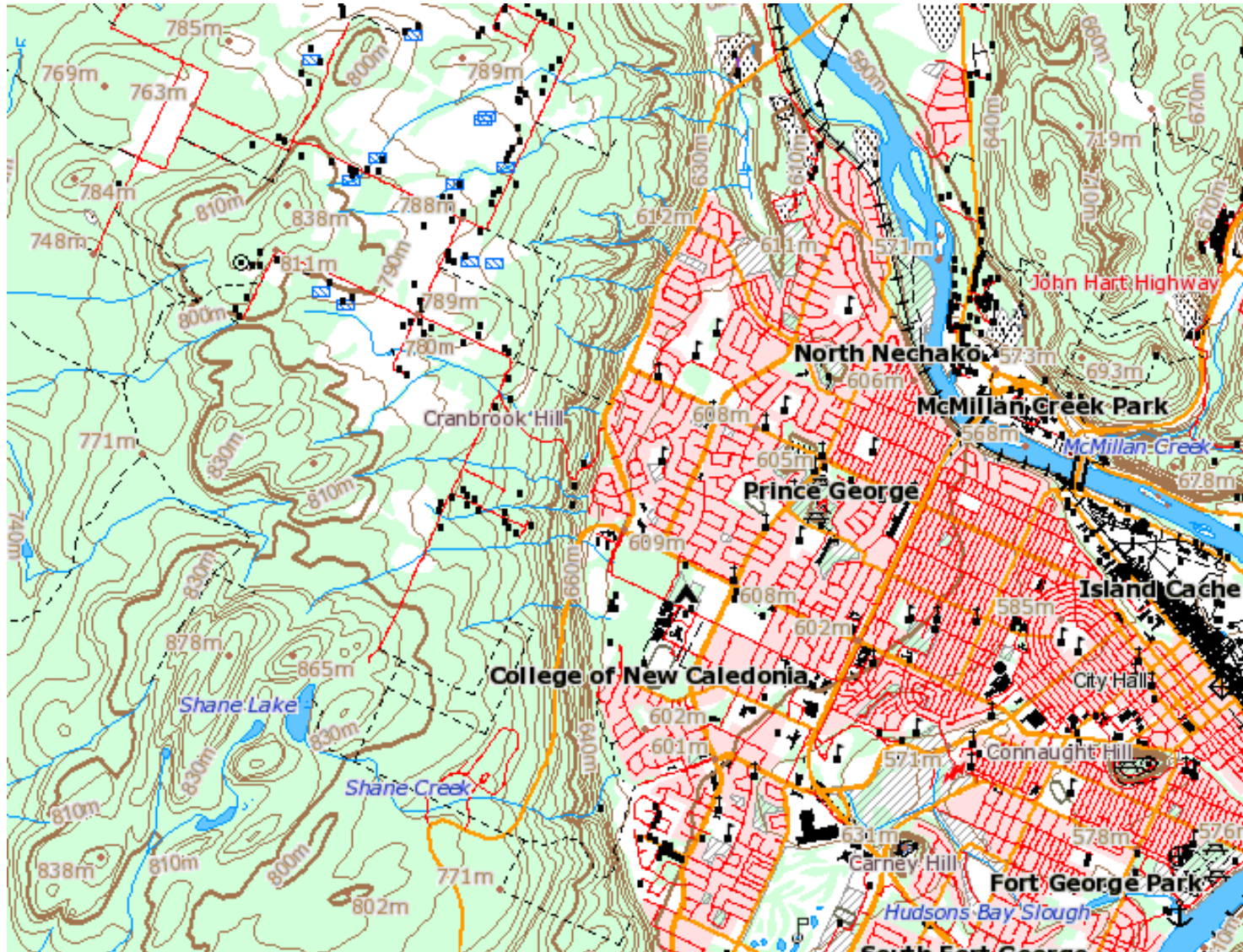
Summary

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>

Contour lines are a standard layer in digital topographic databases and web mapping display. e.g. PGmap; but here generated from DEM

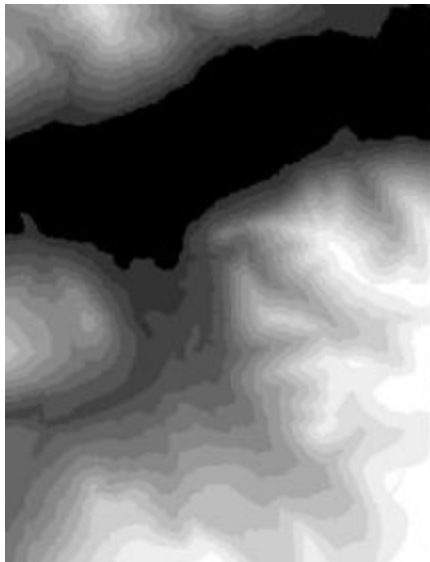


<https://pgmappub.princegeorge.ca/Html5Viewer/?viewer=PGMapMobile>

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

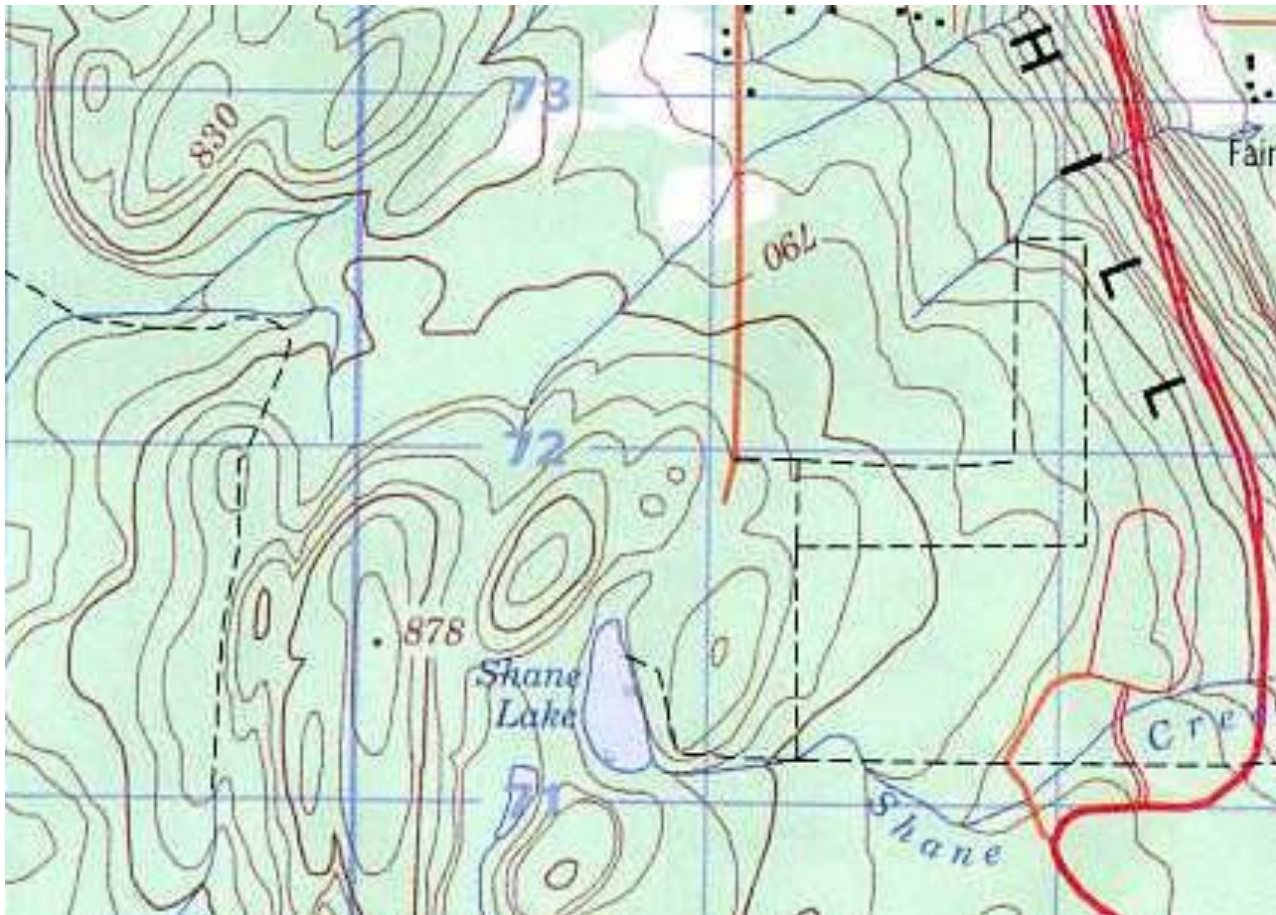
Elevation values in metres

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



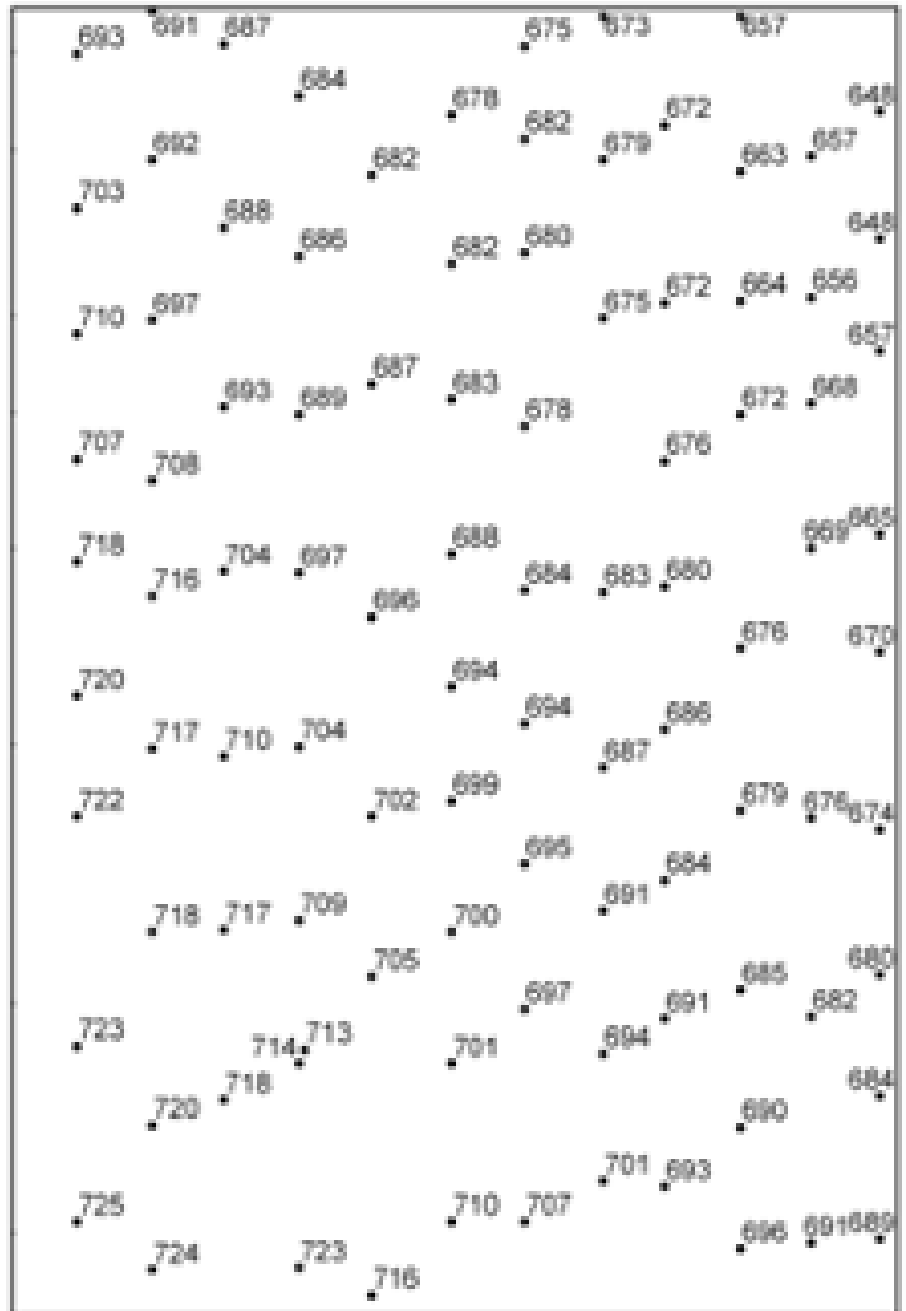
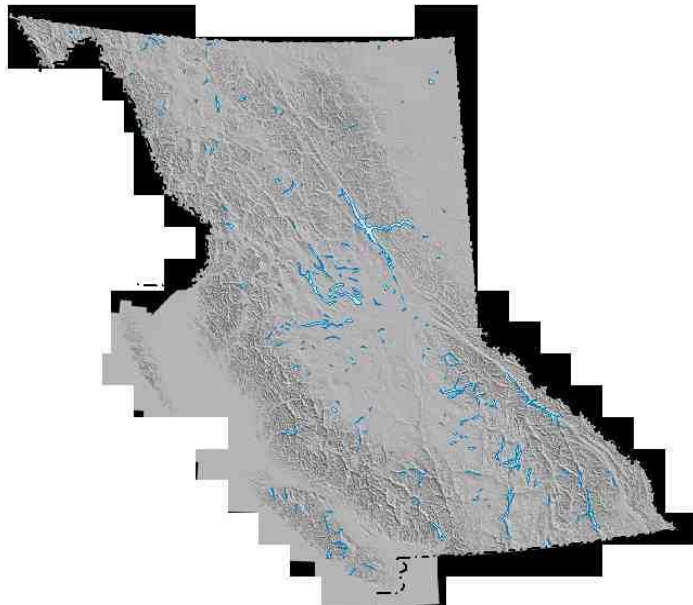
Contours are not DEMS, but can be used to create them ..

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

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

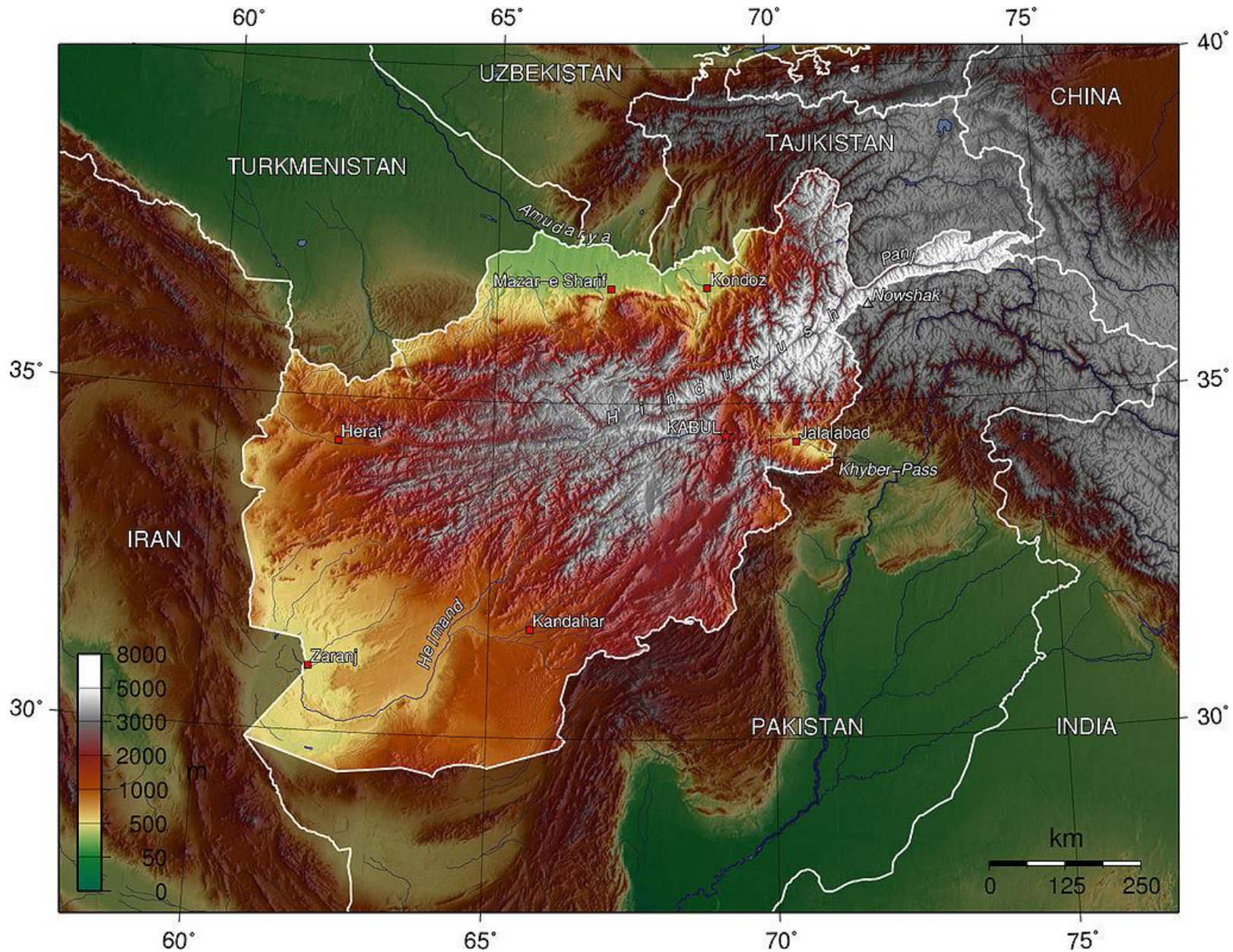
This is a smoother option,
captured directly from
aerial photographs

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



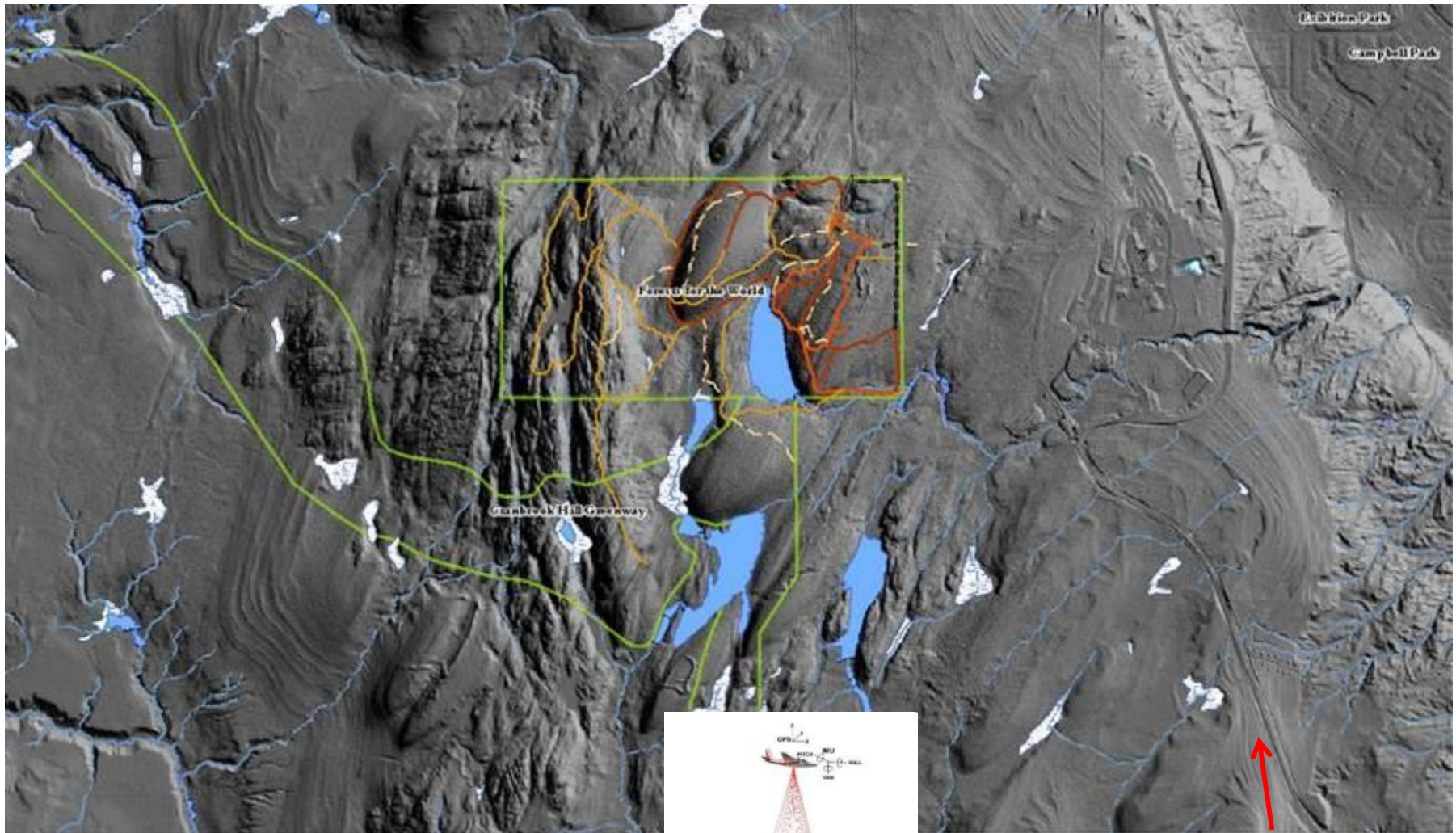
2000-> C. Direct image grid DEM

From satellite raster imagery (1-100 metre pixels)

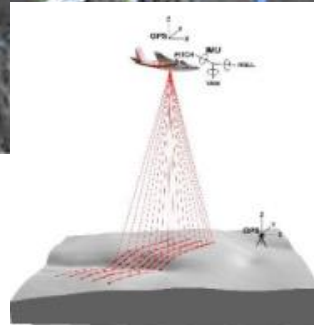


D. LiDAR DEM > 2000 (PGmap, 2014) 1m pixels

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



Vertical resolution ~30cm



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

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	50	NTDB (Canada)
A. Federal	1: 250,000	200	
C. Global	1: 100,000	90	SRTM (Radar) e.g. Google Earth

A: From digitizing contours;
C: satellite image data;

B: masspoints from photogrammetry
D: LiDAR

Summary of common relief depiction methods

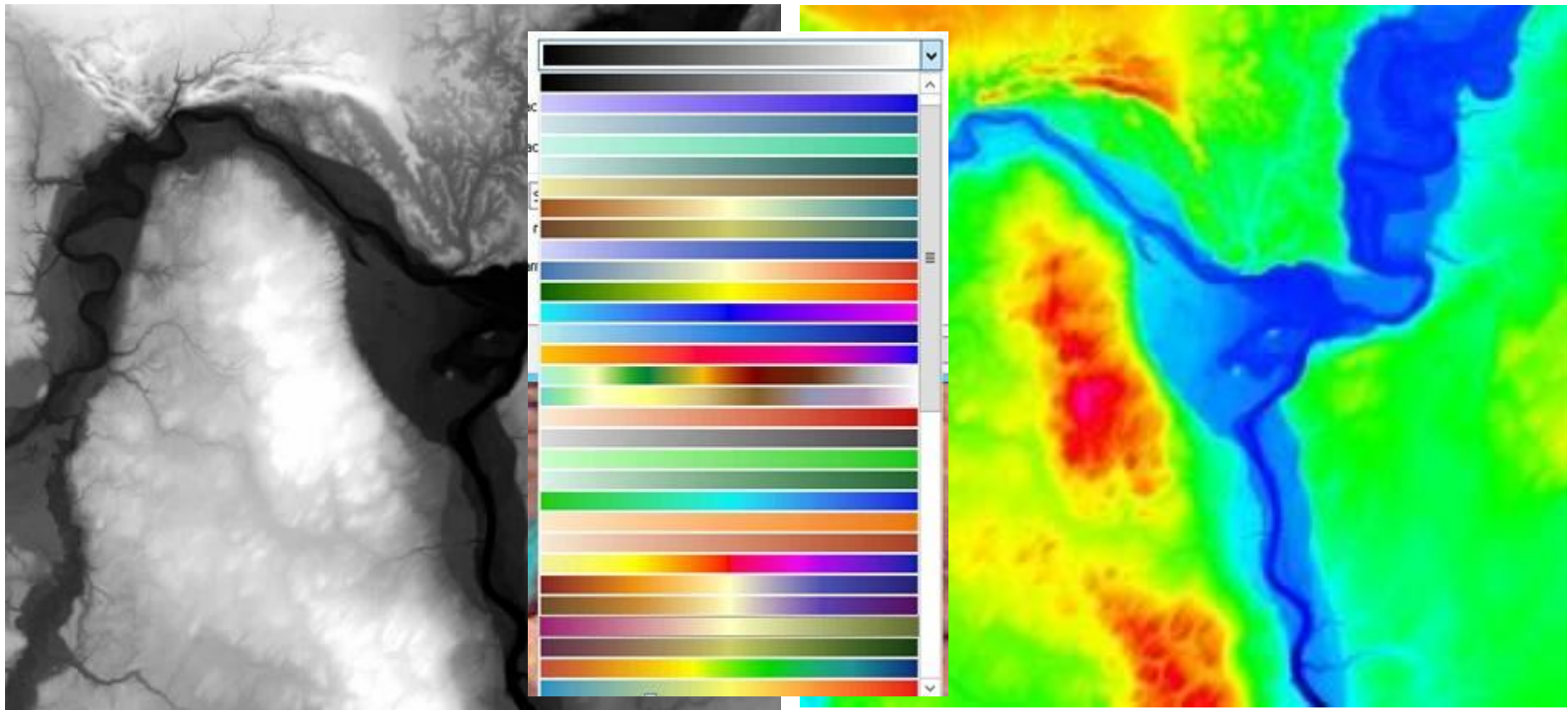
Manually created from contours, but now DEMs	TECHNIQUE	COMPONENT	FEATURES
	Sugar loafs	shape	Simple, stylistic
	Hachures	slope	much ink, no heights
	Spot Heights	elevation	non-visual data points
	Contours	elevation	heights, 'abstract '
	Hyps. tints	elevation	Layer colours
	Shaded relief	aspect	Visual, 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

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

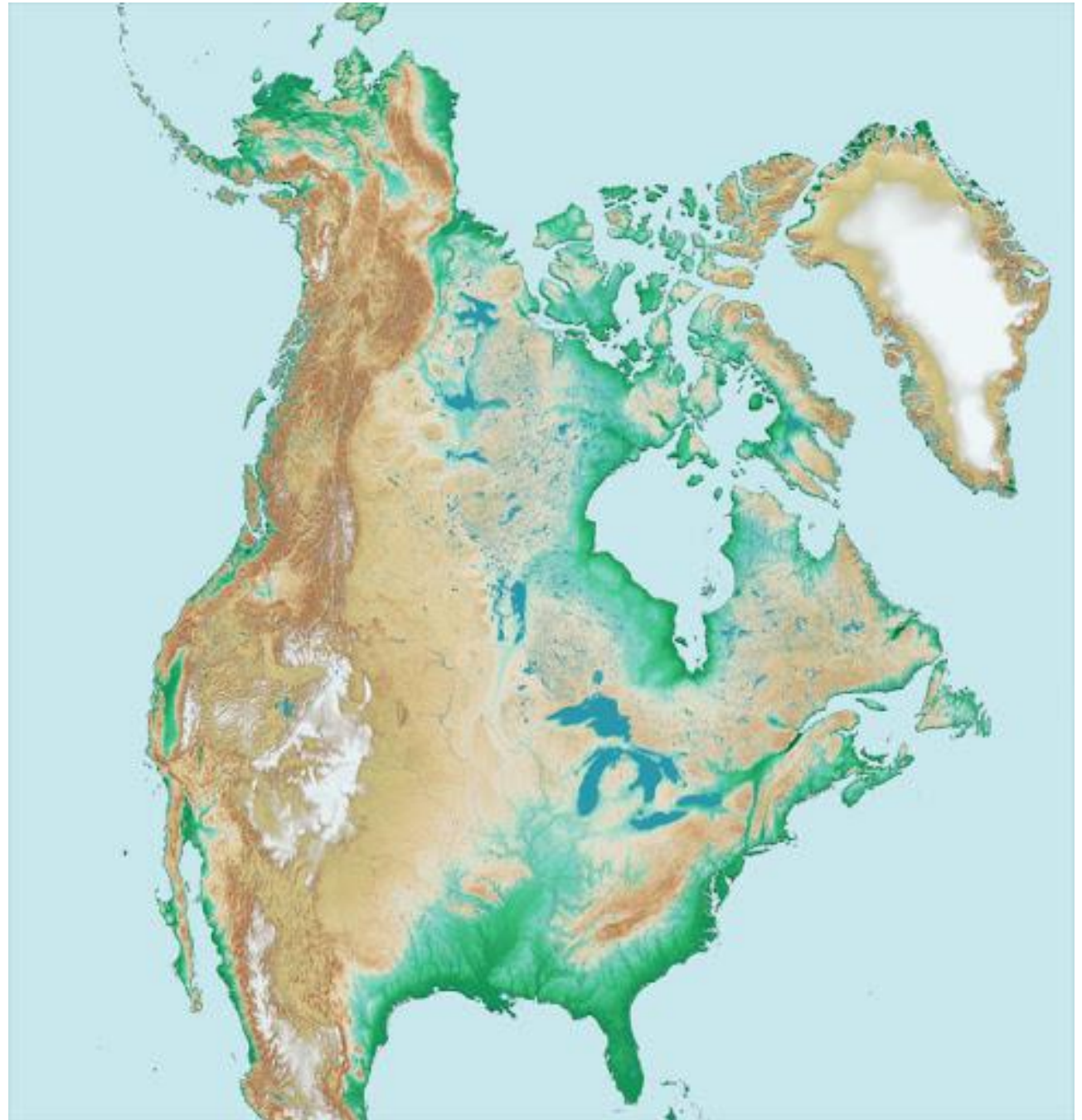


Grayscale is used to store/display elevation data for analysis/viewing – do NOT use for map output

Classified 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

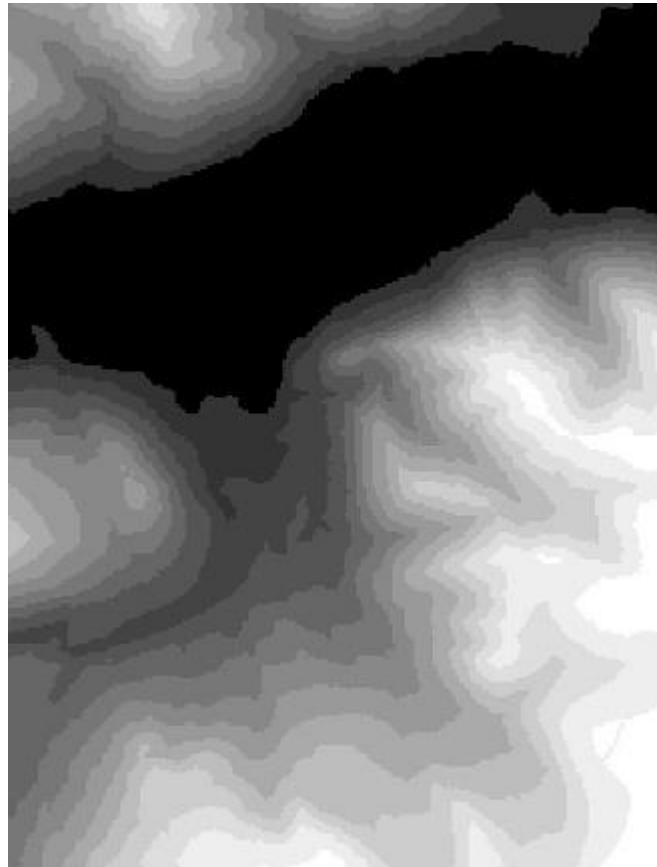
Digital method: digital photos/image -> DEM -> shaded relief

Air Photo



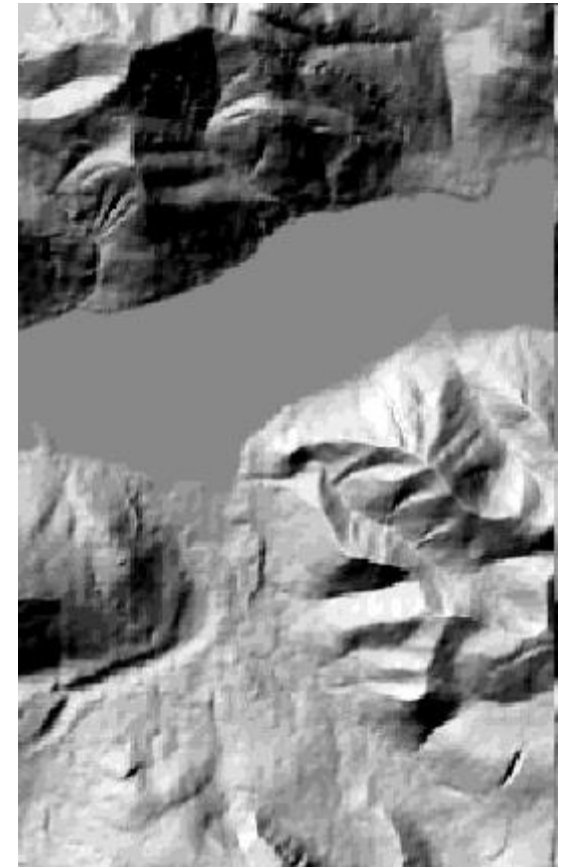
-

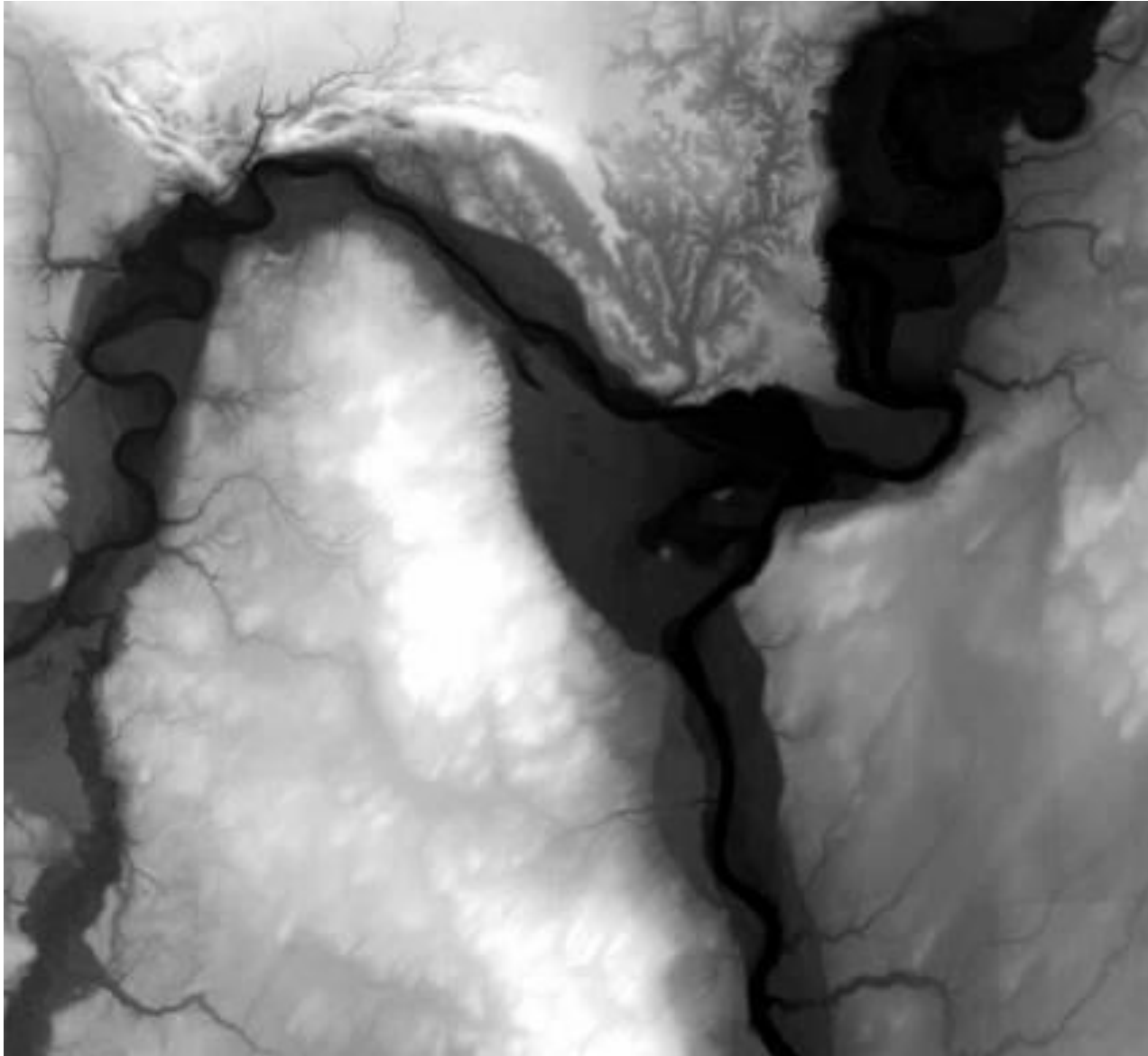
DEM



-

Shaded relief





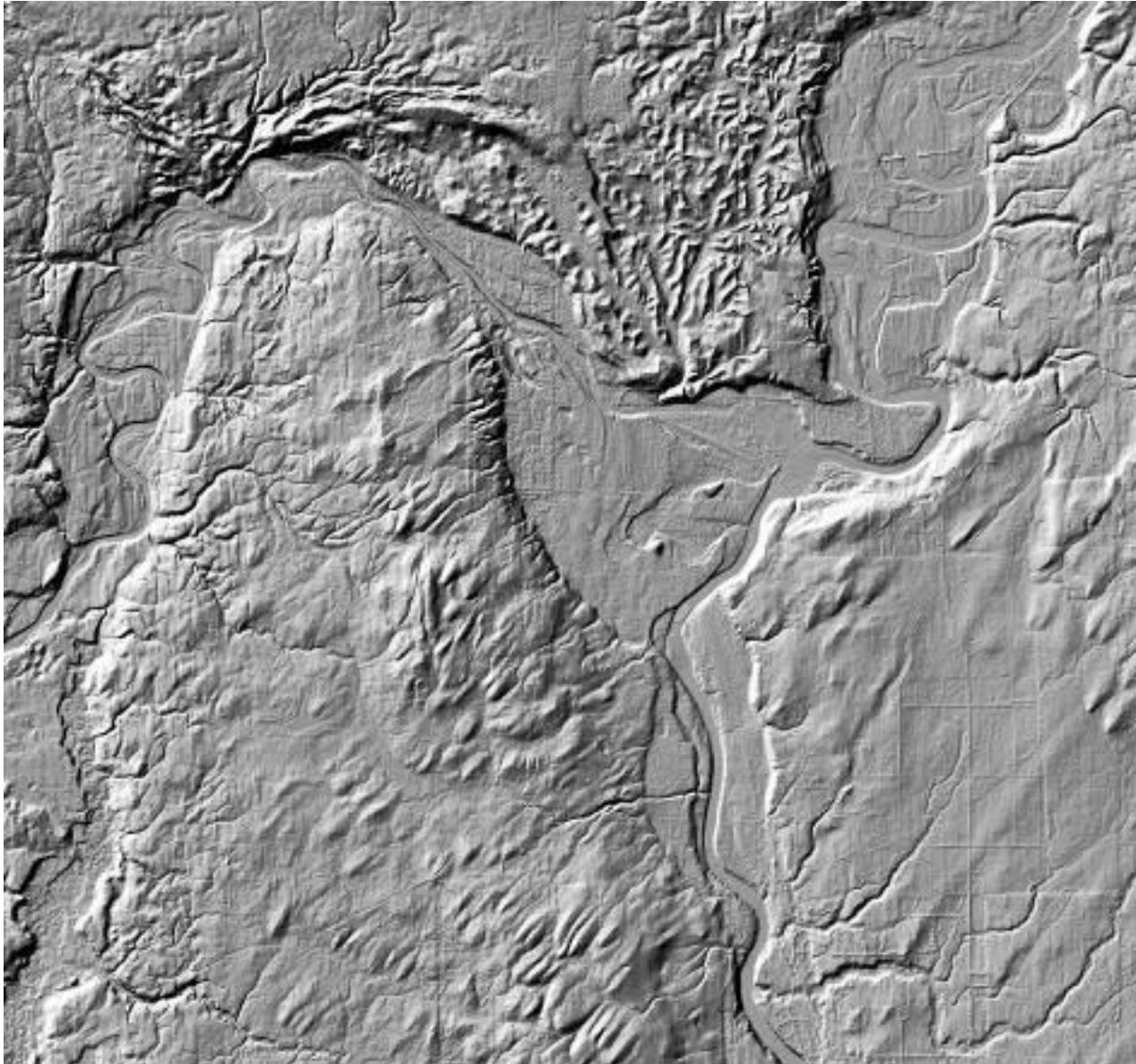
The DEM is used to create tints / hillshade, but is not an effective map layer otherwise

The pixel values = elevation e.g. 760m

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

BC TRIM DEM

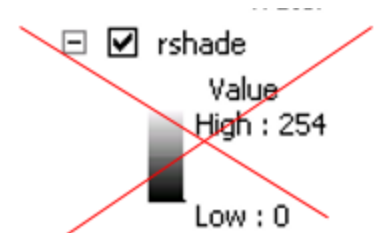
Values = 0-255



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)

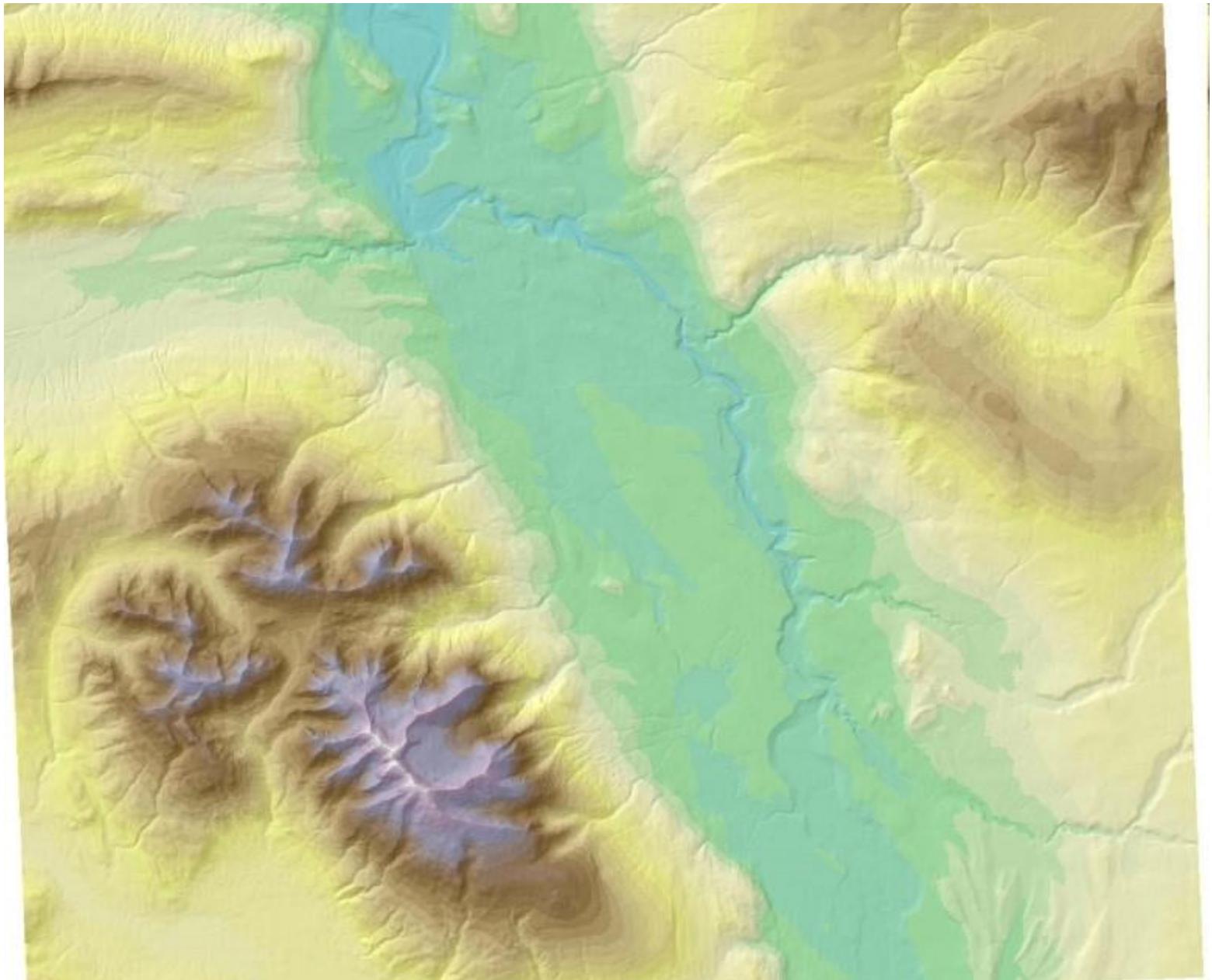




BC iMap: <https://maps.gov.bc.ca/ess/hm/imap4m>

Using software transparency option to combine shading and tints

Routine
GIS
option



Shaded relief (hillshading) plus elevation tints

JLC Geomatique - addition of shaded relief

1/10000 Topographic Maps

NAD 83 / WGS 84

LAC ROSS

1/10 000

1-J

RÉSERVE FAUNIQUE DE
PAPINEAU-LABELLE

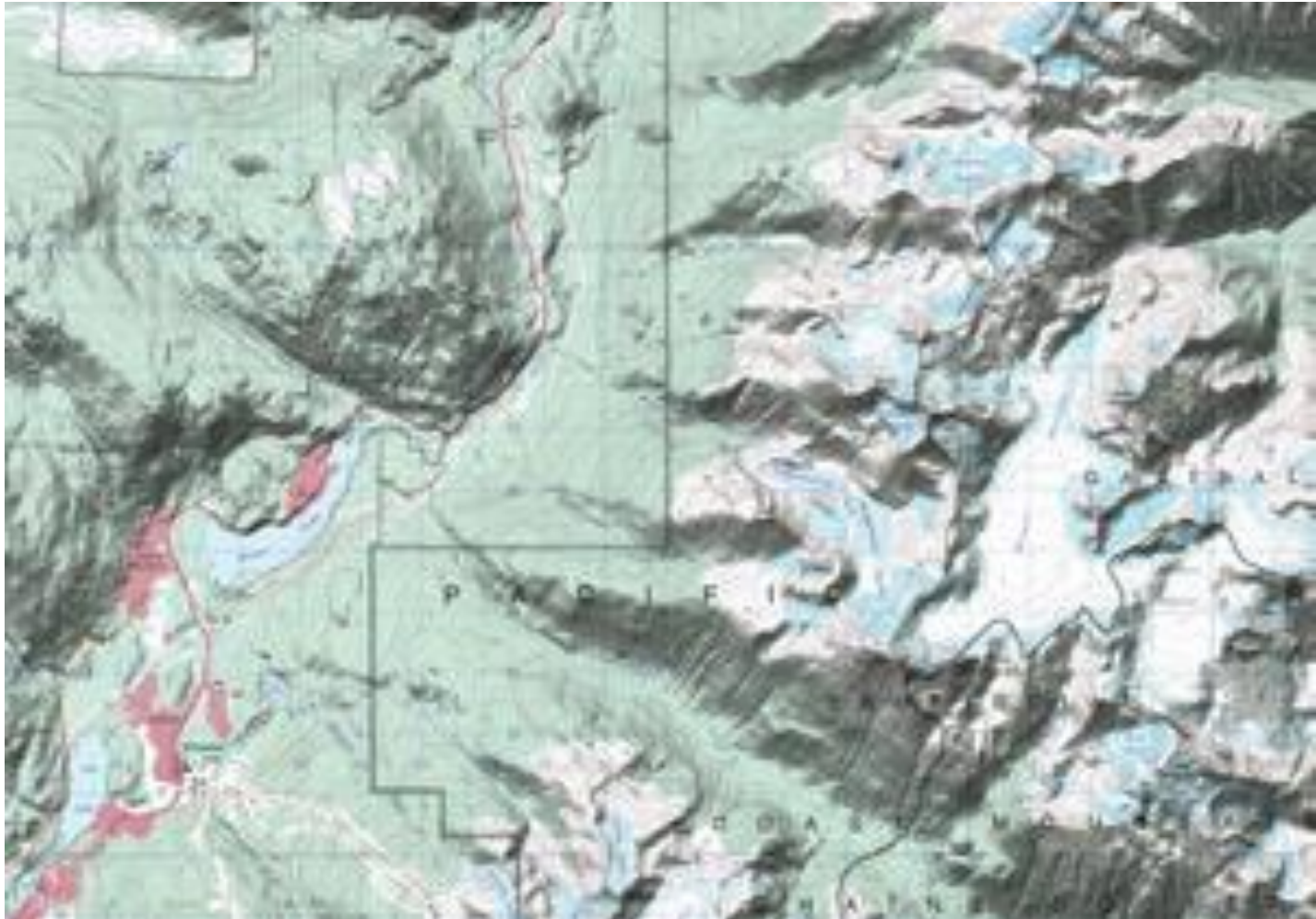


Standard topographic map PLUS added hillshading – available for all Canada NTS maps

Value: easier visualisation of the landscape

<http://gotrekkers.com>

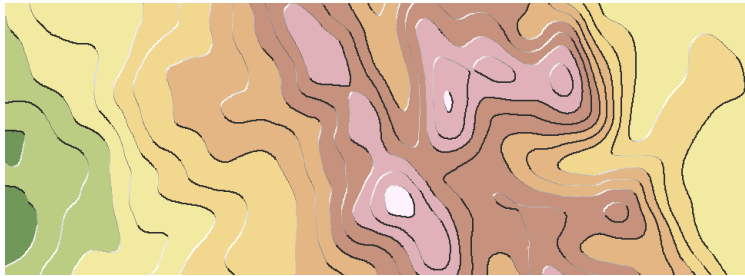
1:50,000,
1:250,000



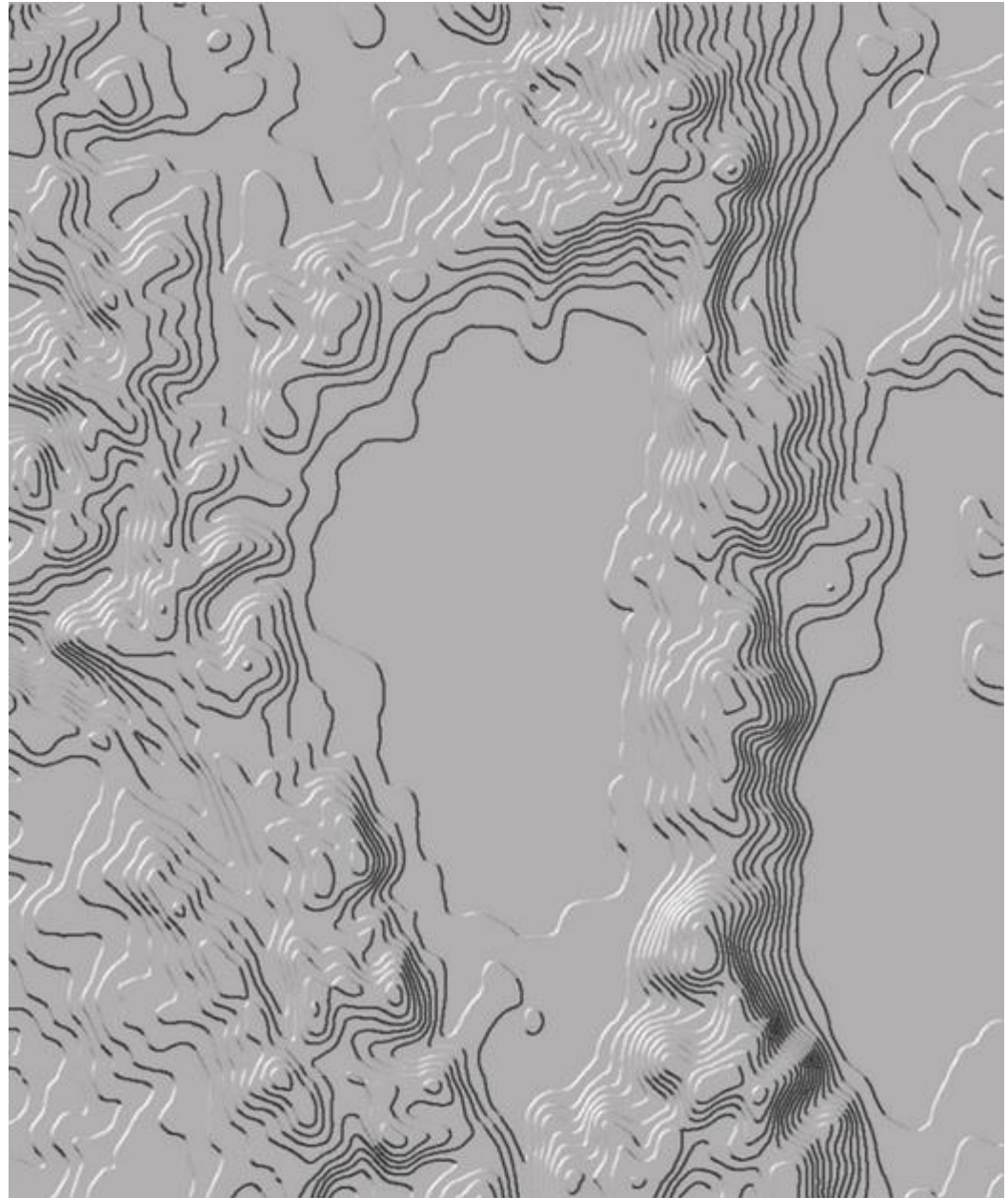
7. Tanaka relief contours

not a common software option

ArcGIS Terrain Tools



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



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



Values = 0-90
(degrees) or also
in % (0->

Bright = steep

Dark = flat

9. (2.5D) perspectives (and flythroughs) - Google Earth, ArcScene



User selects viewpoint, angle,
vertical exaggeration, 'drape
layers, e.g. labels, roads

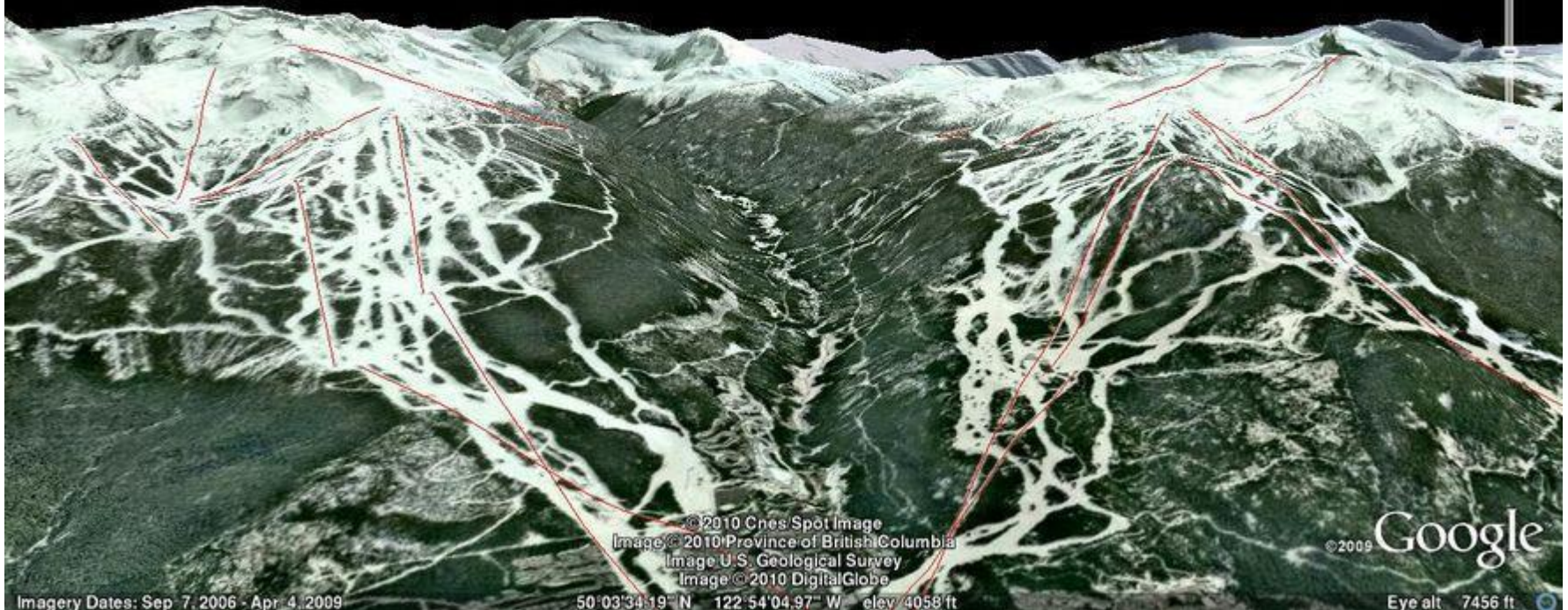
Plus "fly-through" animations

Hand-drawn

THE MAN BEHIND THE MAP

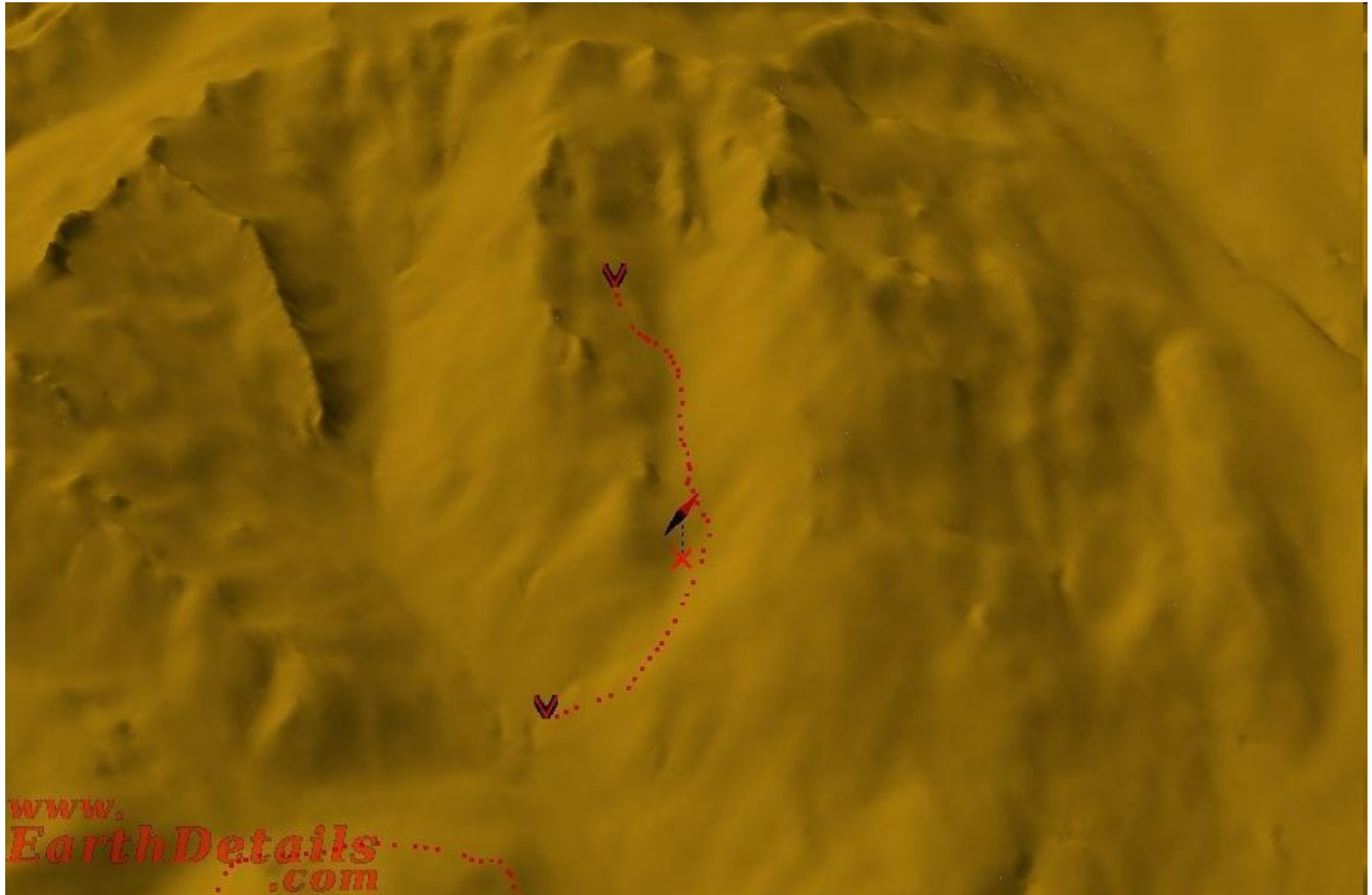
Hand painted mountain maps by James Niehues

[VIEW ART](#)

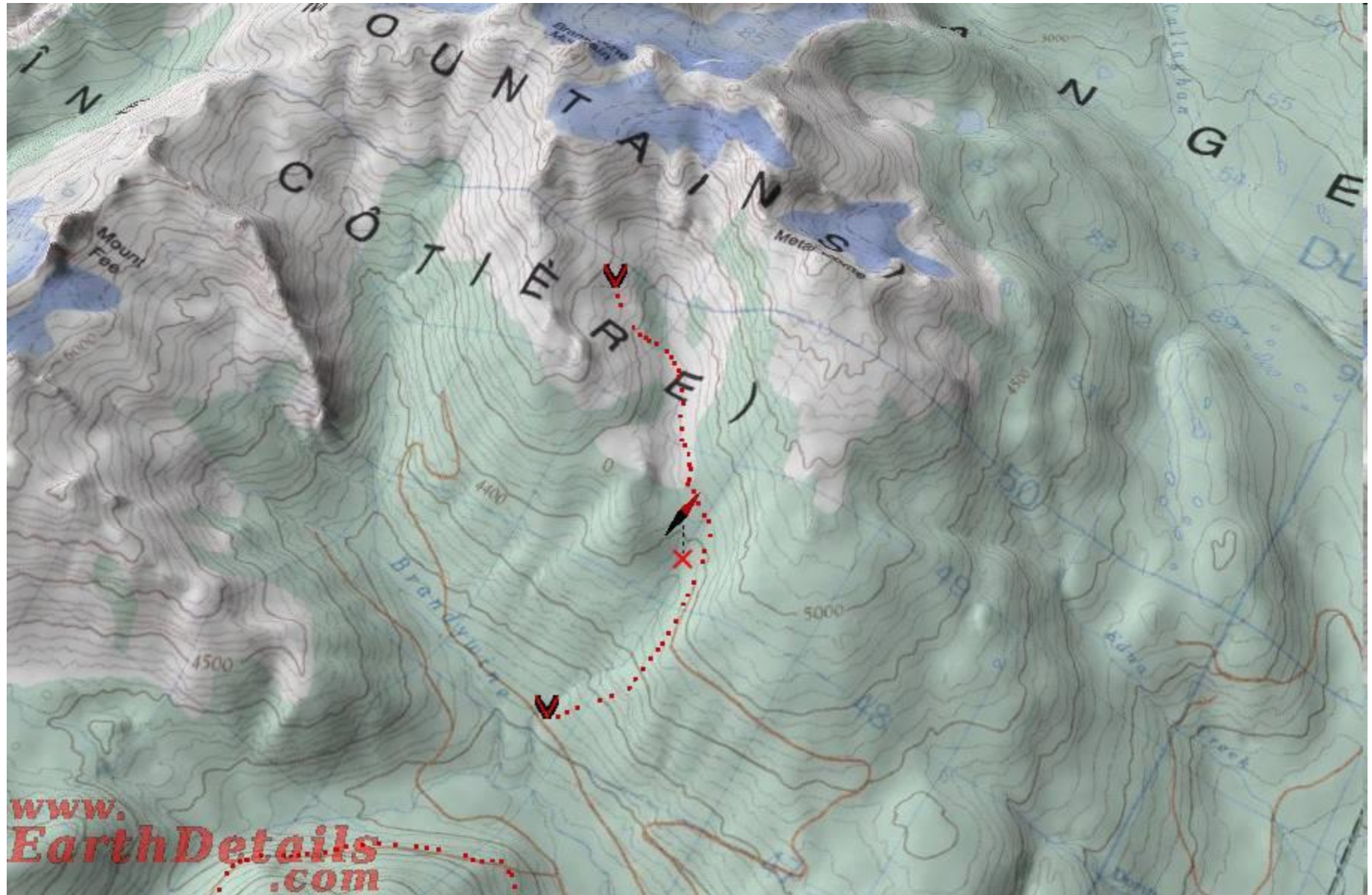


Google Earth as Perspectives for ski hills e.g. Whistler-Blackcomb

9. Perspectives



Whistler - Brandywine Meadows - with 'draped' NTS map



10. True 3D physical models

WORLD'S LARGEST PHYSICAL TERRAIN MODEL

IS THE CENTERPIECE OF THE NEW "BC EXPERIENCE"

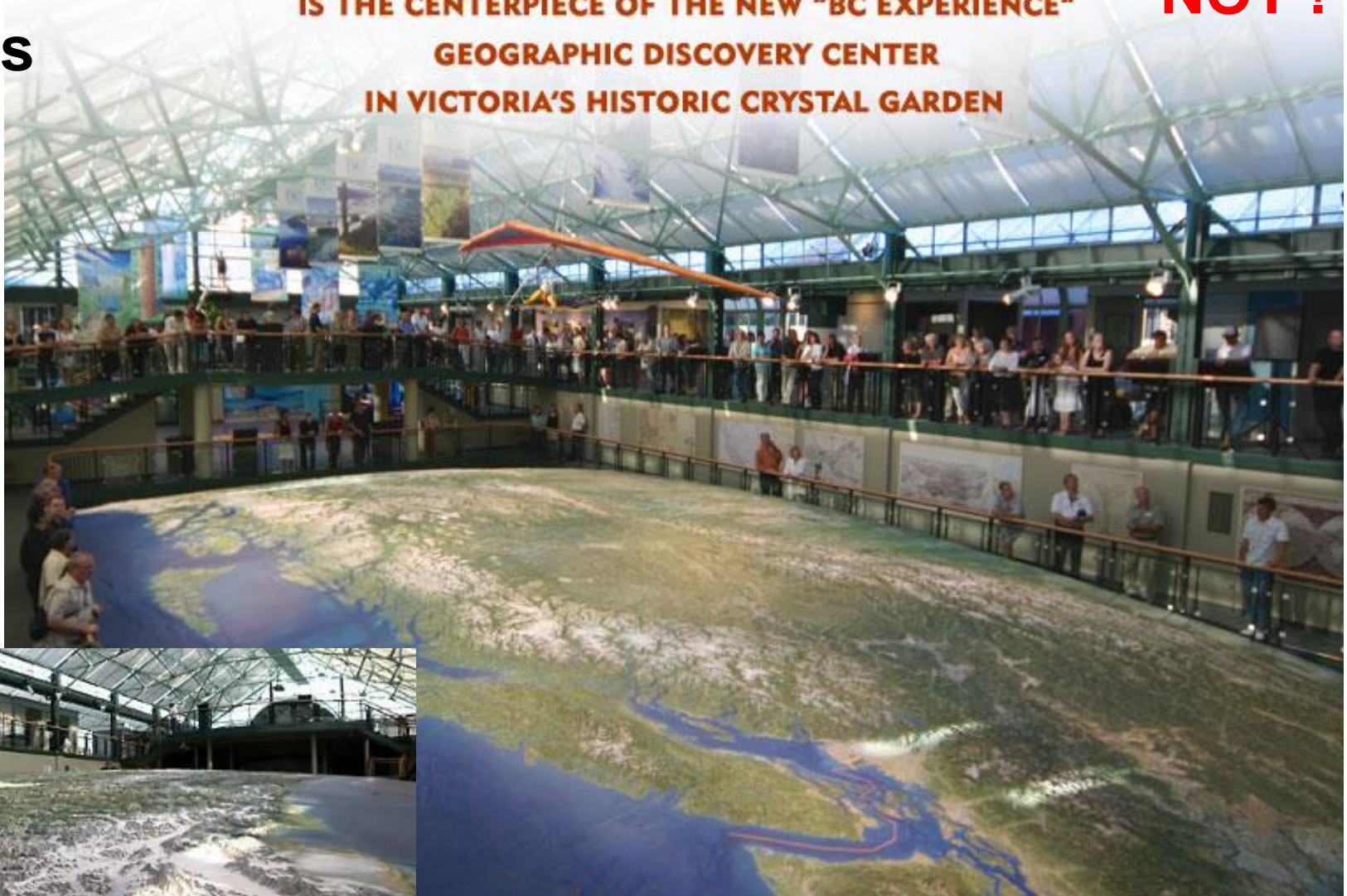
NOT !

GEOGRAPHIC DISCOVERY CENTER

IN VICTORIA'S HISTORIC CRYSTAL GARDEN

-40 x 74'
1:99,000)

-Solid
Terrain
Modelling
Cut by
laser



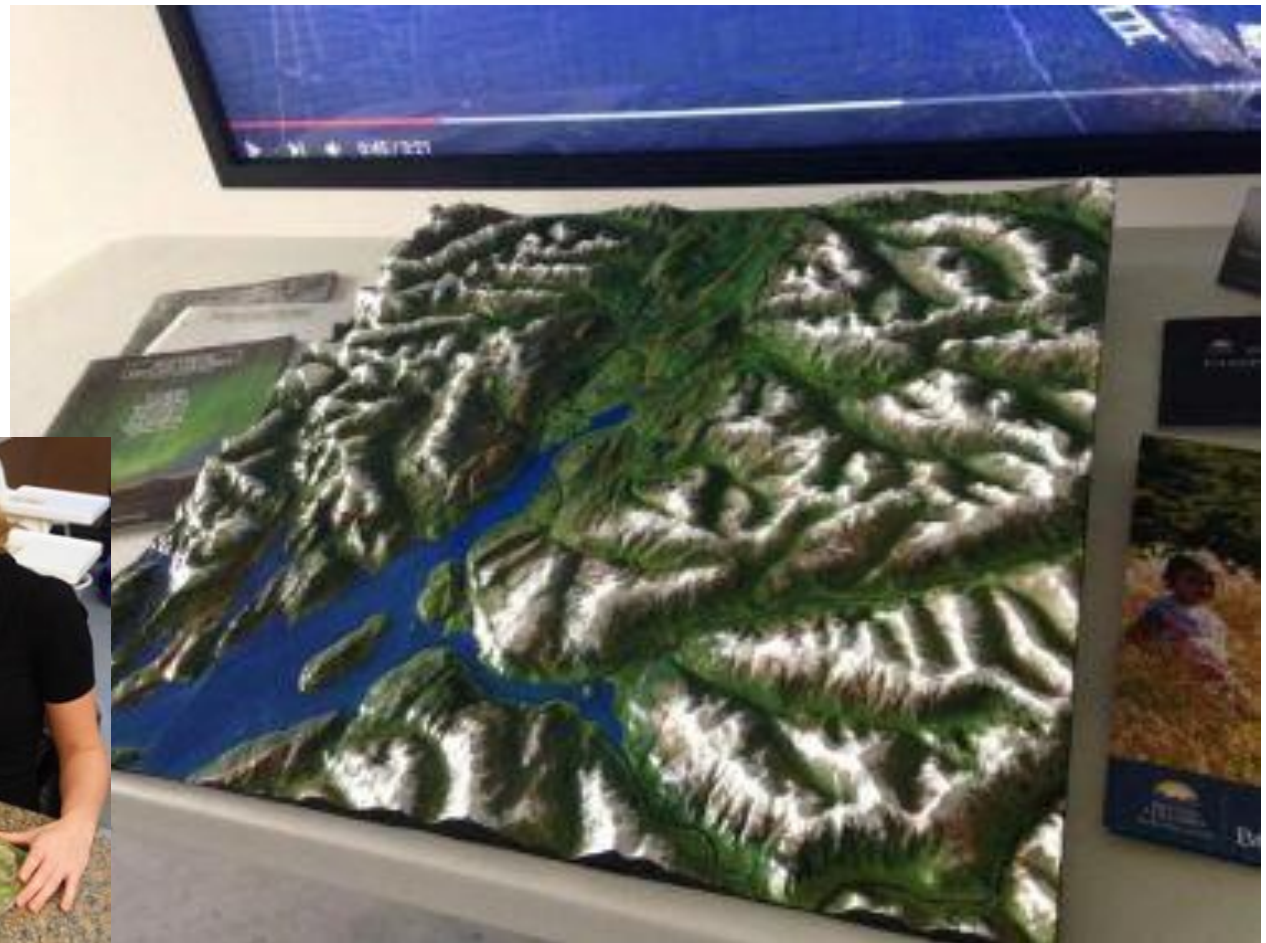
*Note: Jack Challenger's BC wood map is 25 x 25m
Manually carved / created 1945-52, now in storage*

3d printer, Filaprint, Tumbler Ridge

<http://www.filaprint.ca/>



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