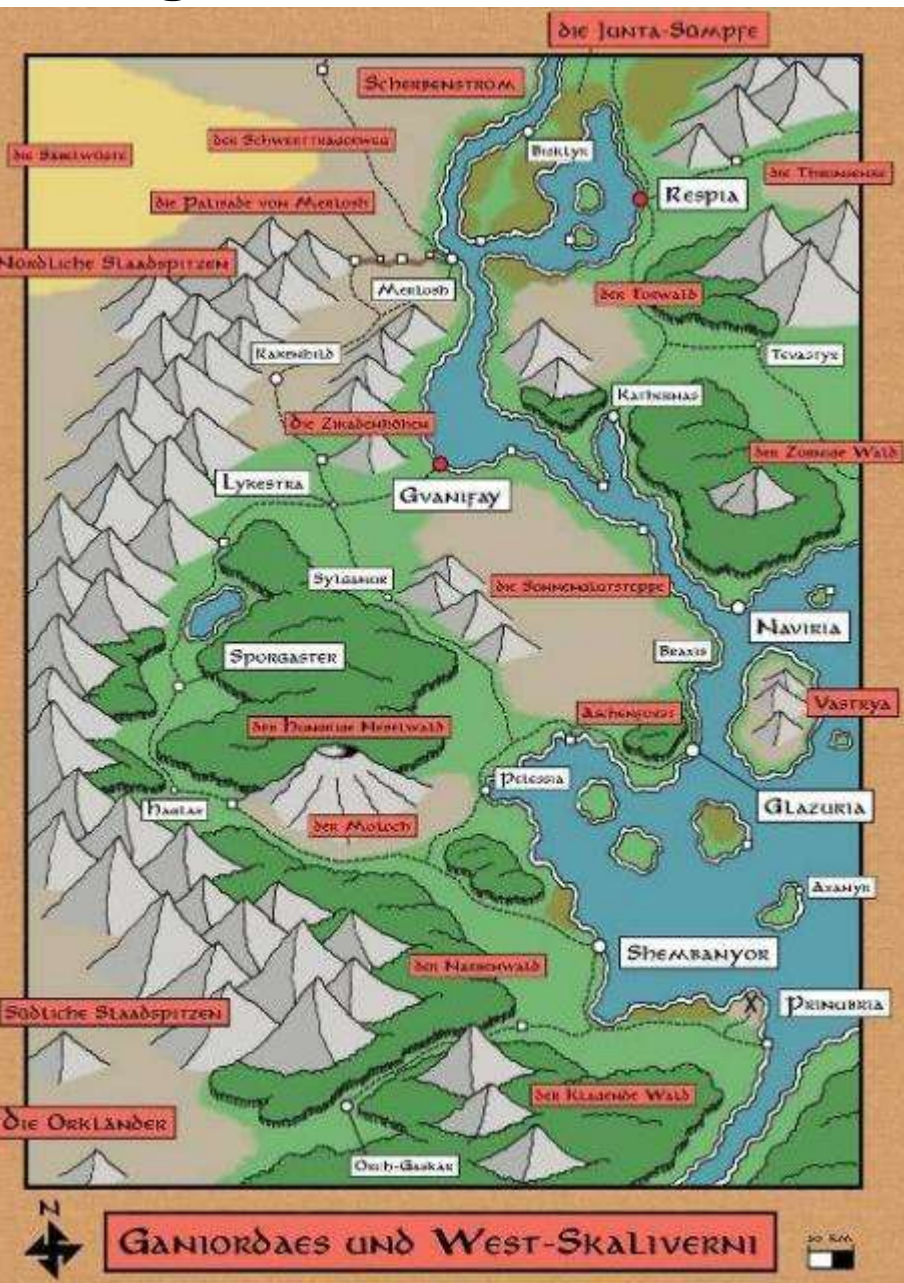# Digital Elevation Models (DEMs)
How has relief depiction changed with digital mapping /GIS ?
'Geovisualisation'

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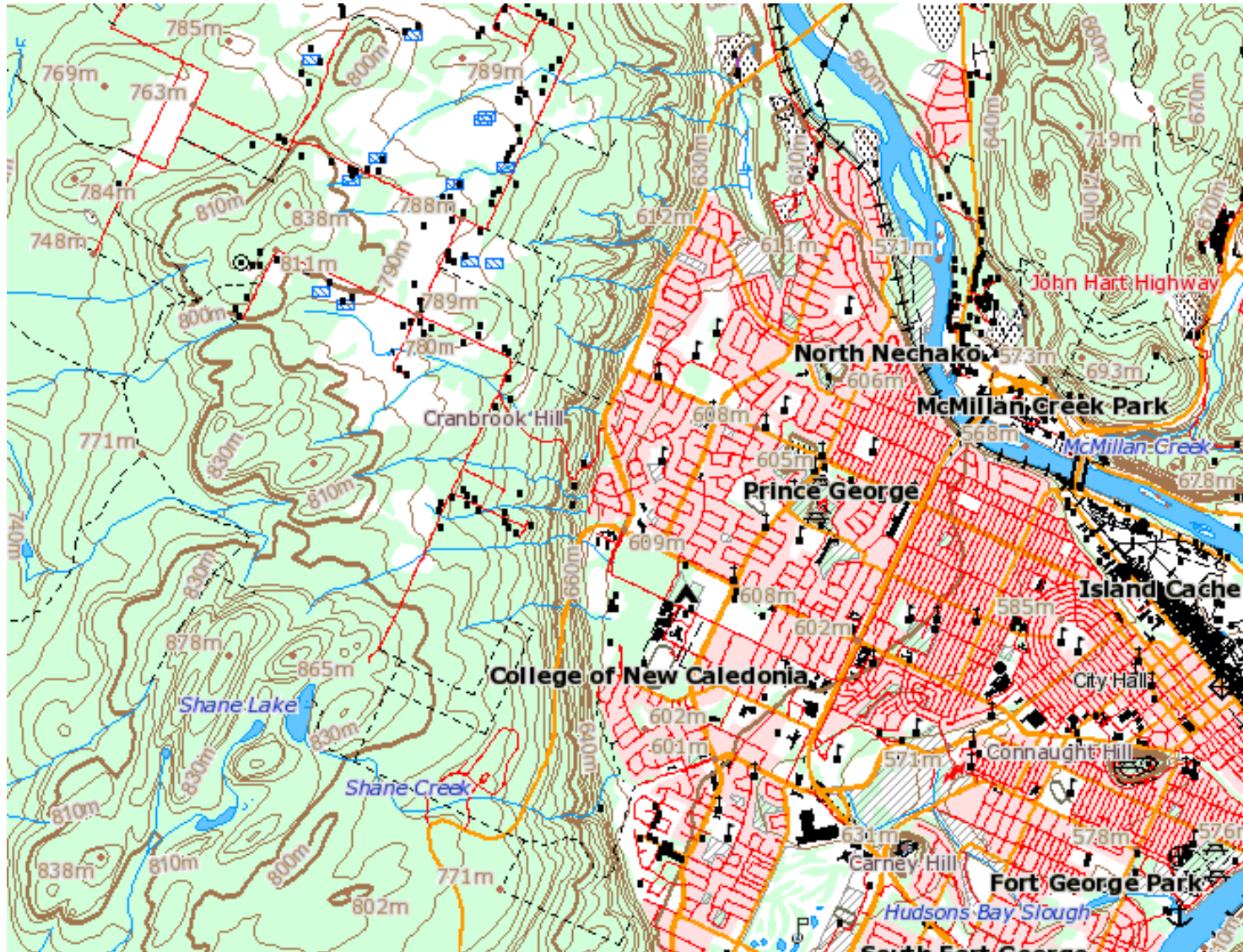

copy/paste … repeat !

2. Hachures - not a common software option

show orientation of slope, by their thickness and a general sense of steepness

Experimental only in GIS / digital software to 'make maps look old'

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

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 for display. e.g. PGmap

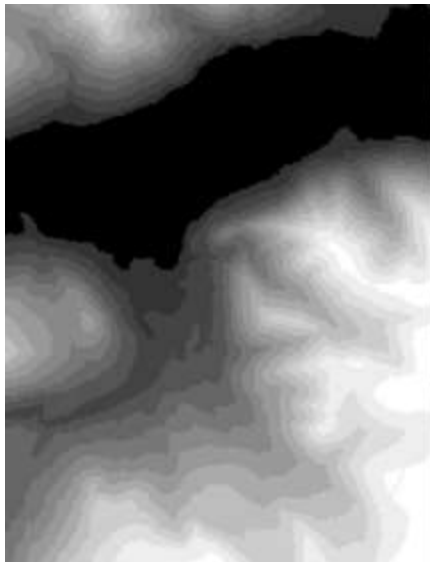https://pgmappub.princegeorge.ca/Html5Viewer/?viewer=PGMapMobile

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

Digital Elevation Models (DEM)
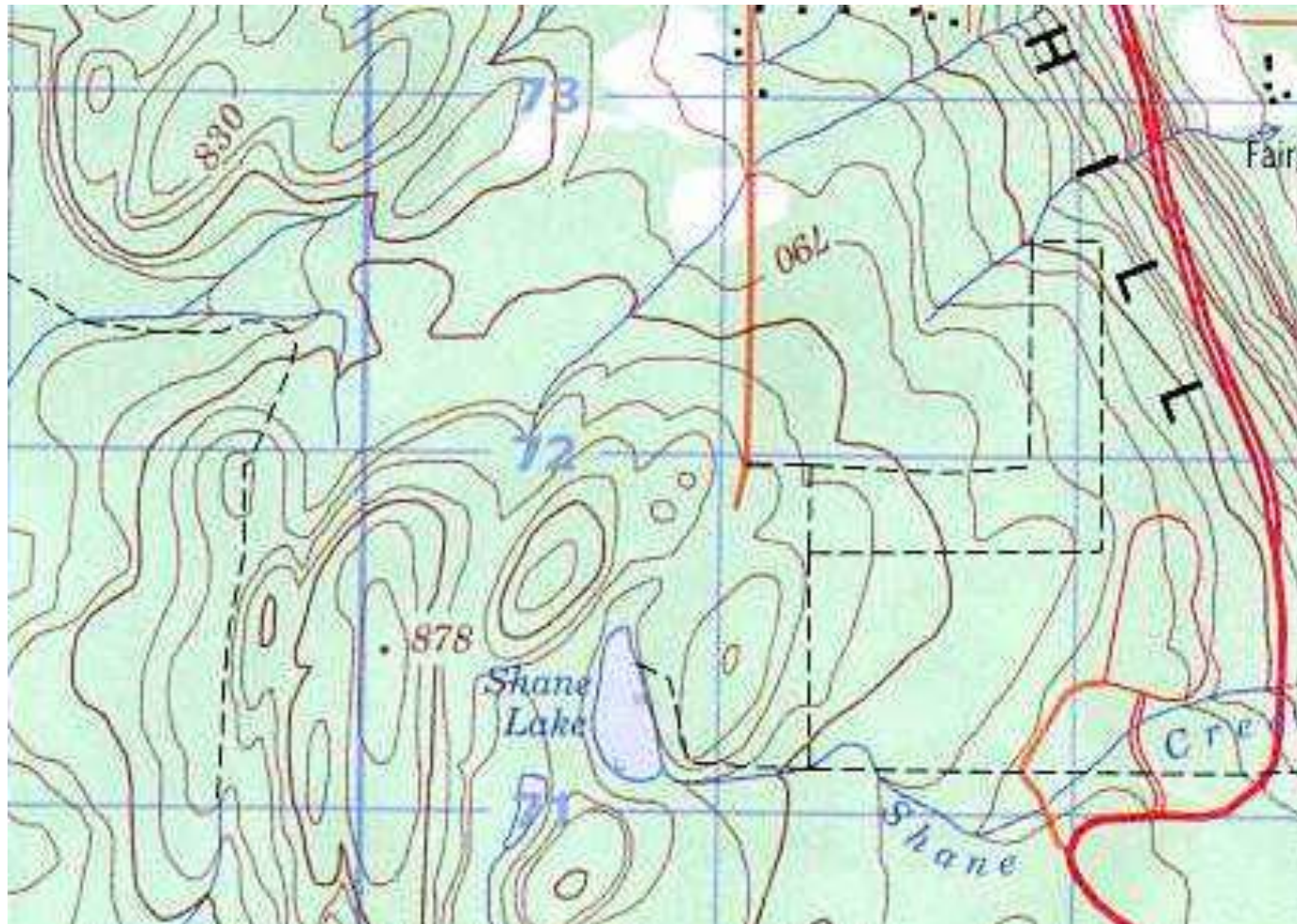## also (e.g. Europe) Digital Terrain Models (DTM)

Digital Surface Models (DSM) e.g. vegetation canopy, buildings

DEM creation methods

A> by digitising contours (e.g. NTS maps -> NTDB layer)
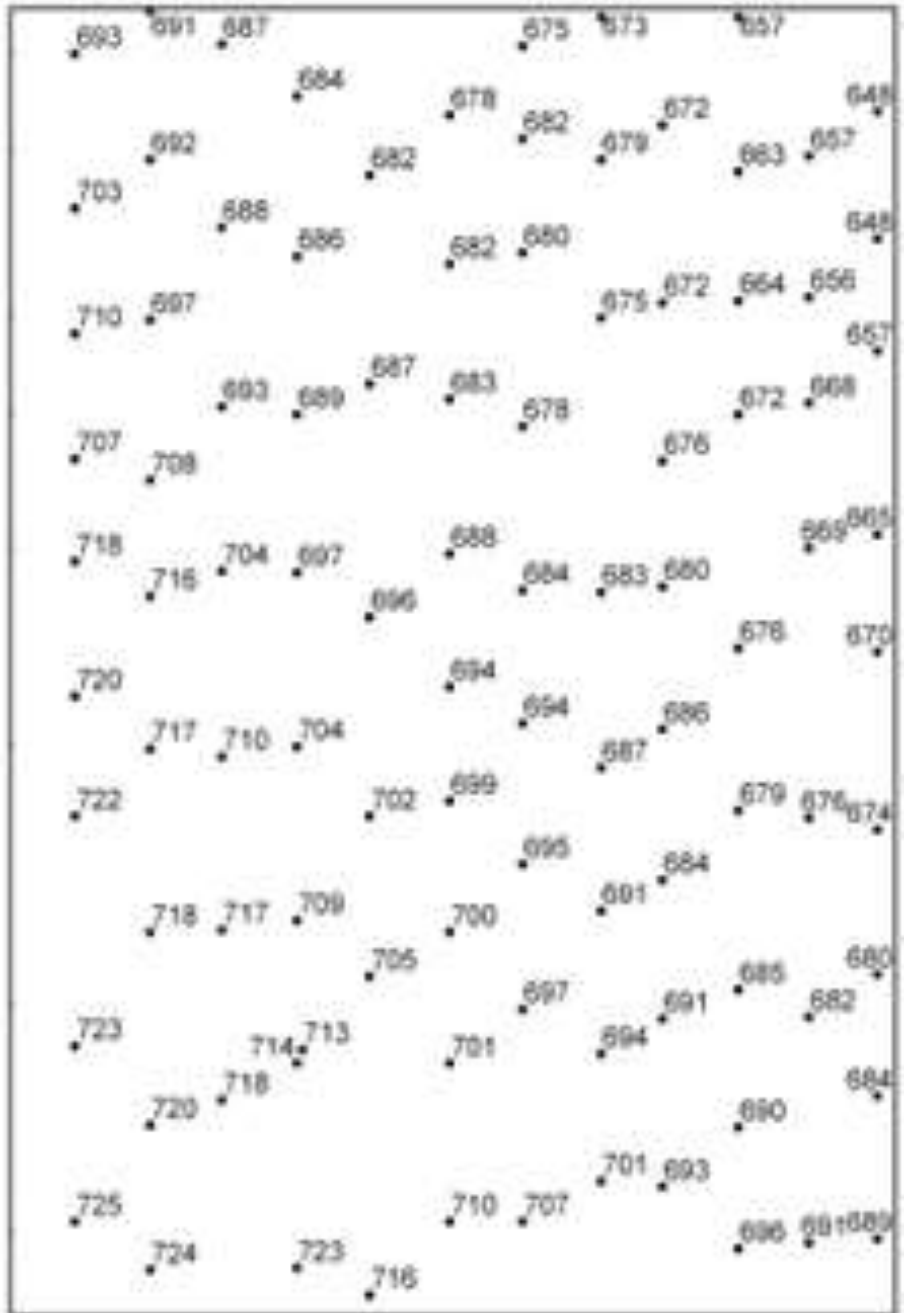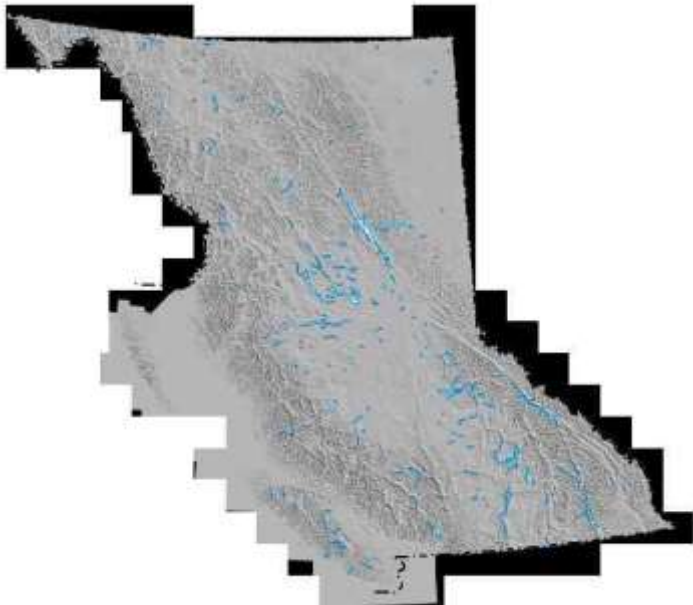
- Done for all of Canada (~1985-95)

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

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 ArcMap: 'topo to raster'

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

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

DEM generation

Digital contours or points –> interpolate to raster DEM

ArcGIS tool: 'Topo to Raster'

The DEM is the modern source of relief layers (not contours)

DEM creation: **C. Direct image grid DEM** (> 2000)
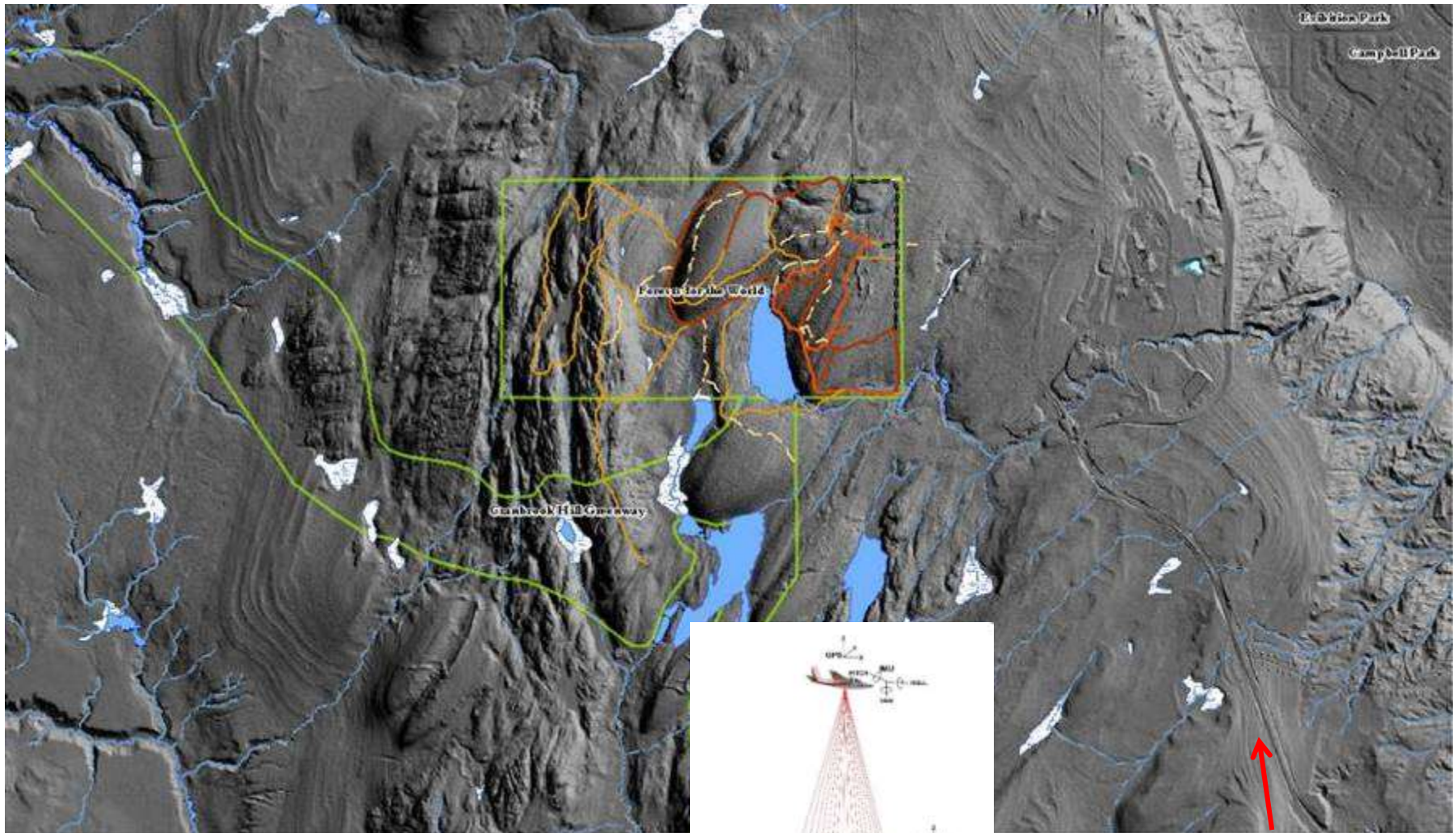From satellite raster imagery   (1-100 metre pixels)

Satellite imagery -> DSM ;   Aerial photography -> DTM

D. LiDAR DEM > 2000 (PGmap, 2014)
most Canadian cities have a LiDAR DEM
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 – except maybe the top one in this list

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; 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'
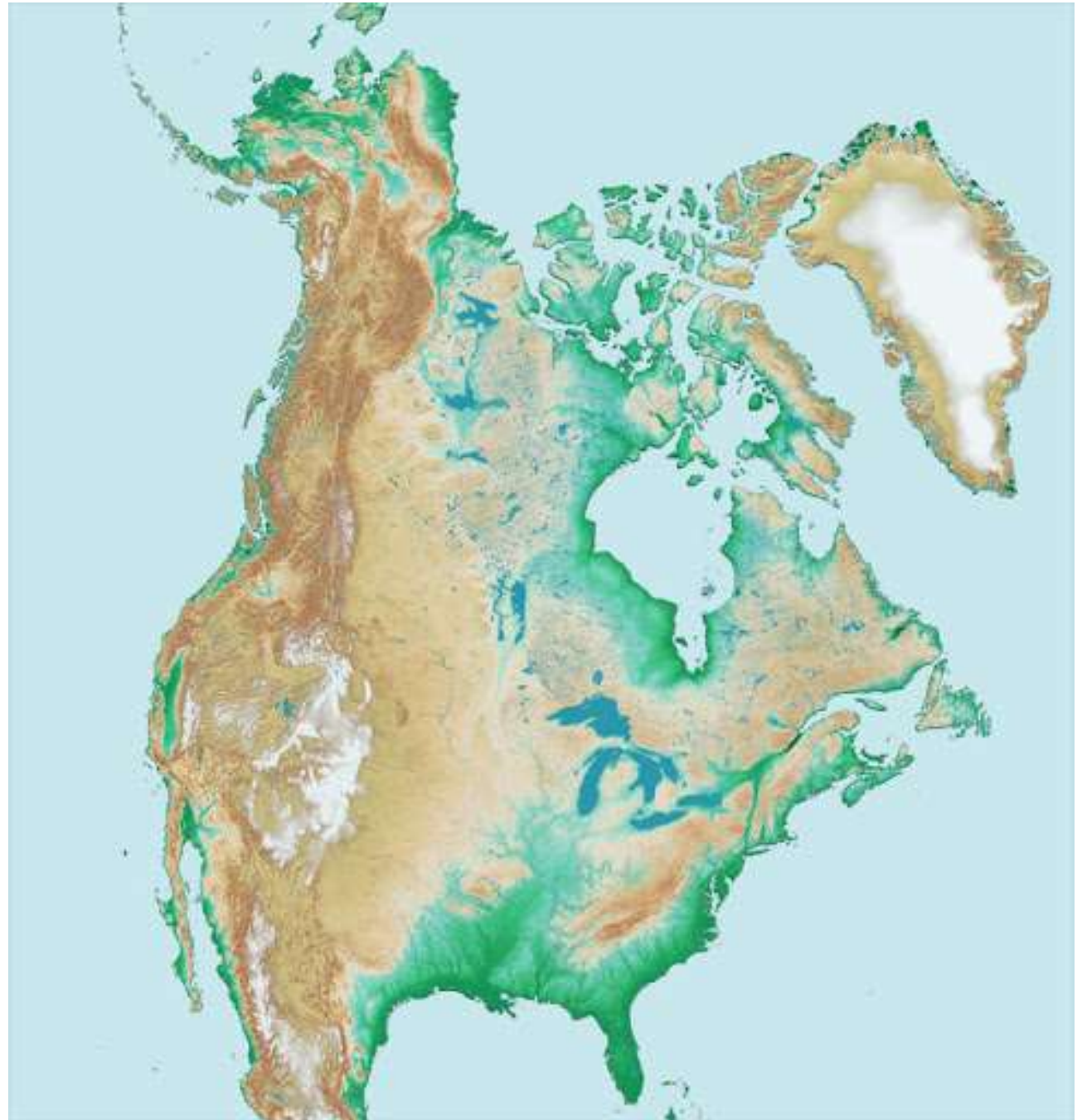elevation values (usually) in metres
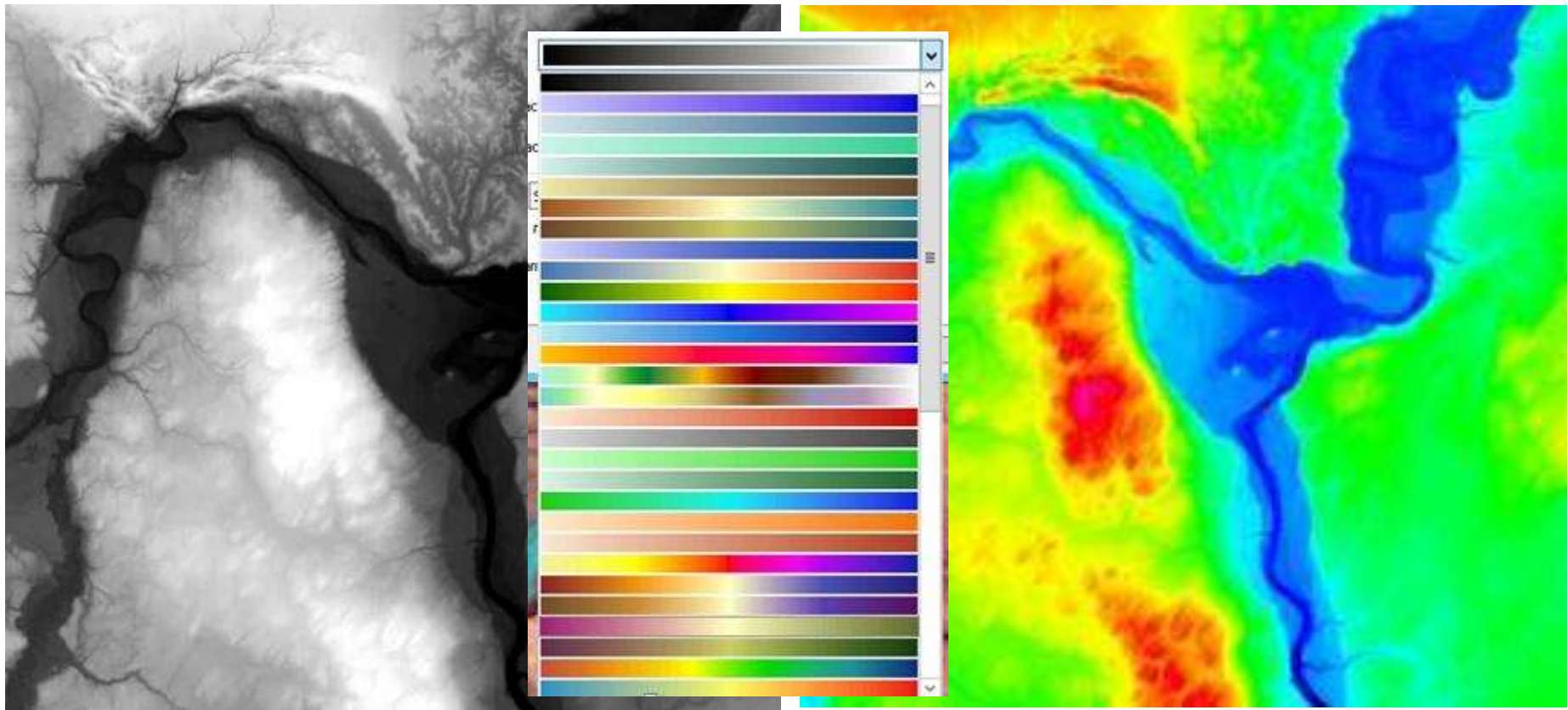
Grayscale is used to store/display elevation data for analysis/viewing – do <u>NOT</u> use for map output

Classified layer tints

Easy to produce
and modify

**As the crow flies
cARTography, ON**

6. Shaded relief (hillshade)

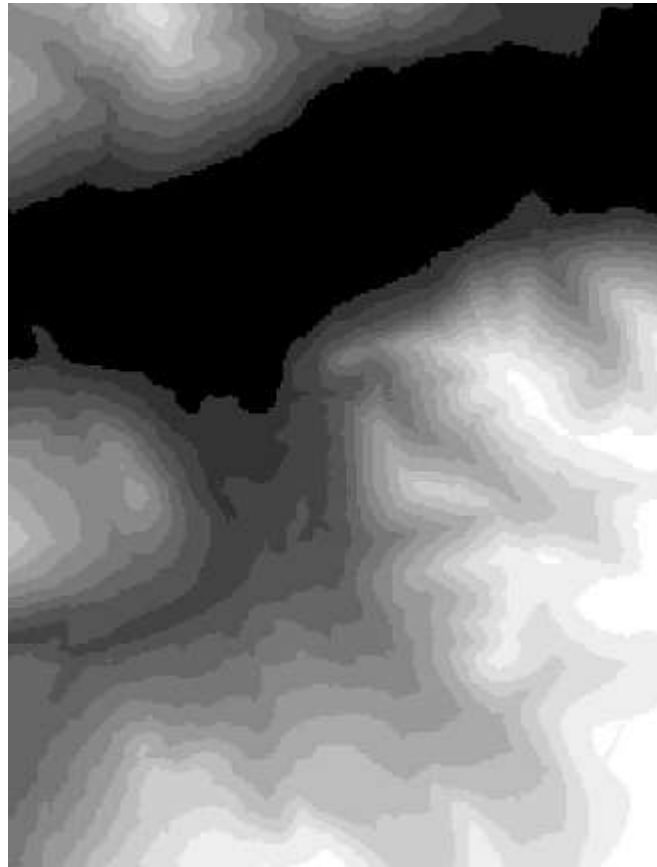Analogue method: photos –> contours -> sketch shaded relief
Digital method: digital photos/image -> DEM –> shaded relief
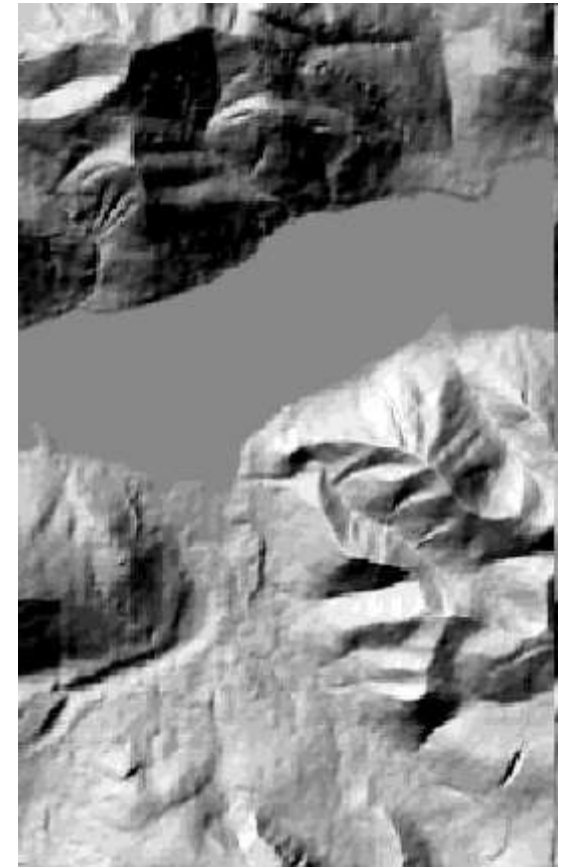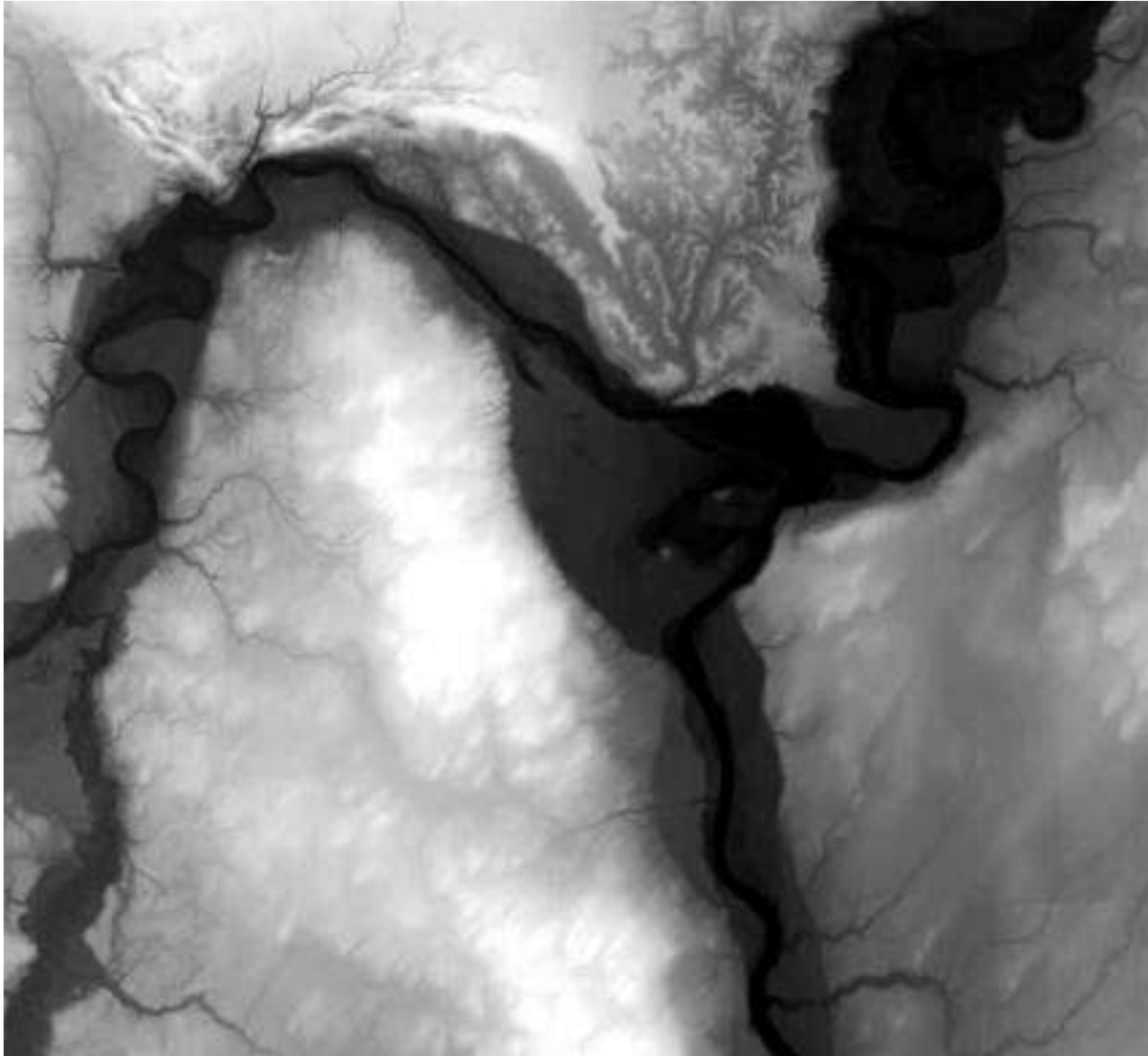
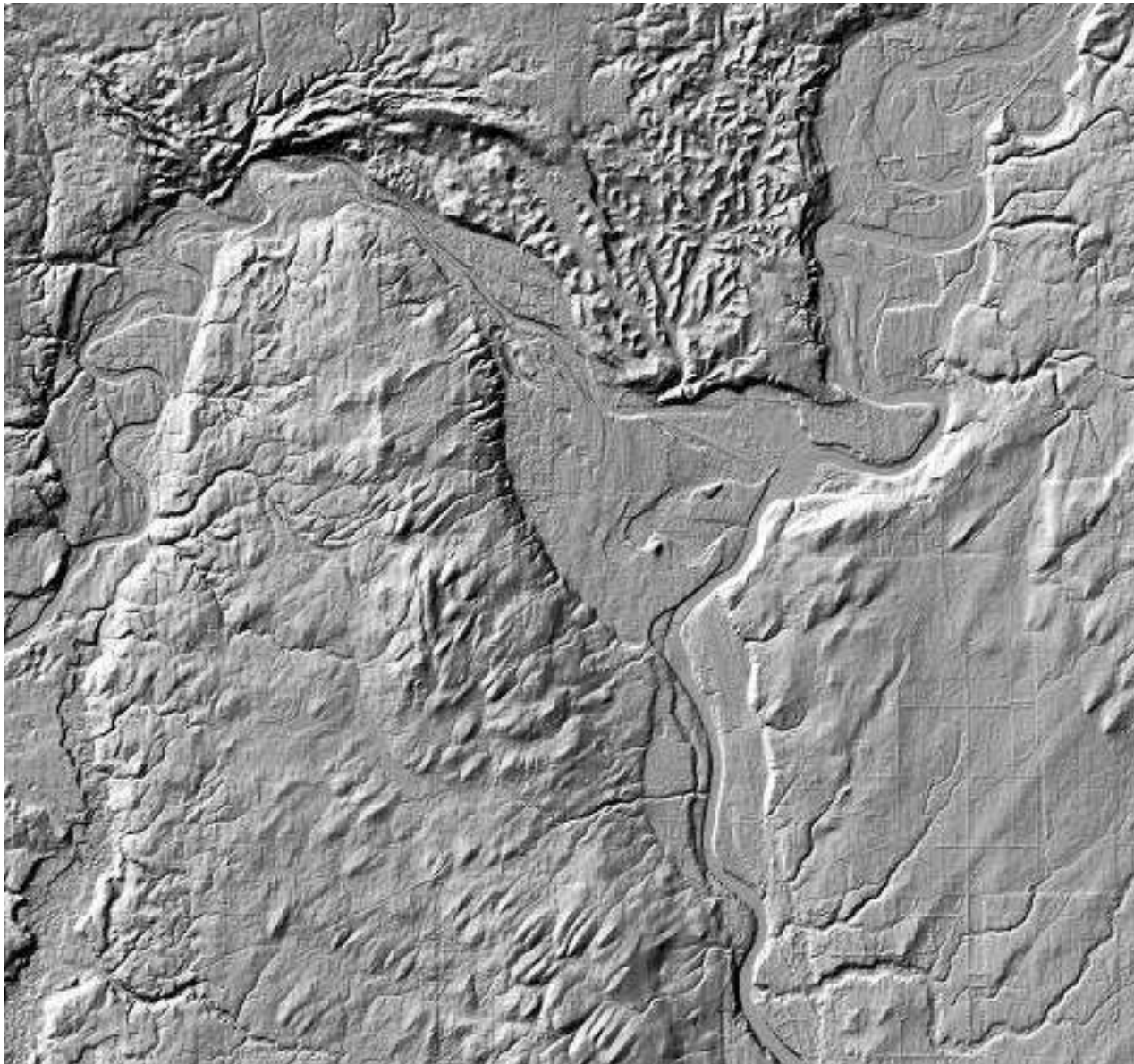Air Photo   -   DEM   -   Shaded relief

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

The pixel values = elevation e.g. 760m

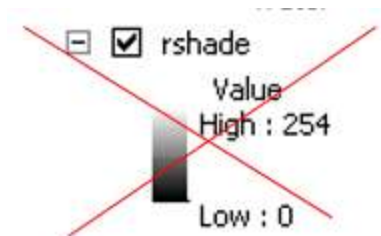# Shaded relief (hillshading) : No need for artistic ability.

BC TRIM DEM   Values = 0-255

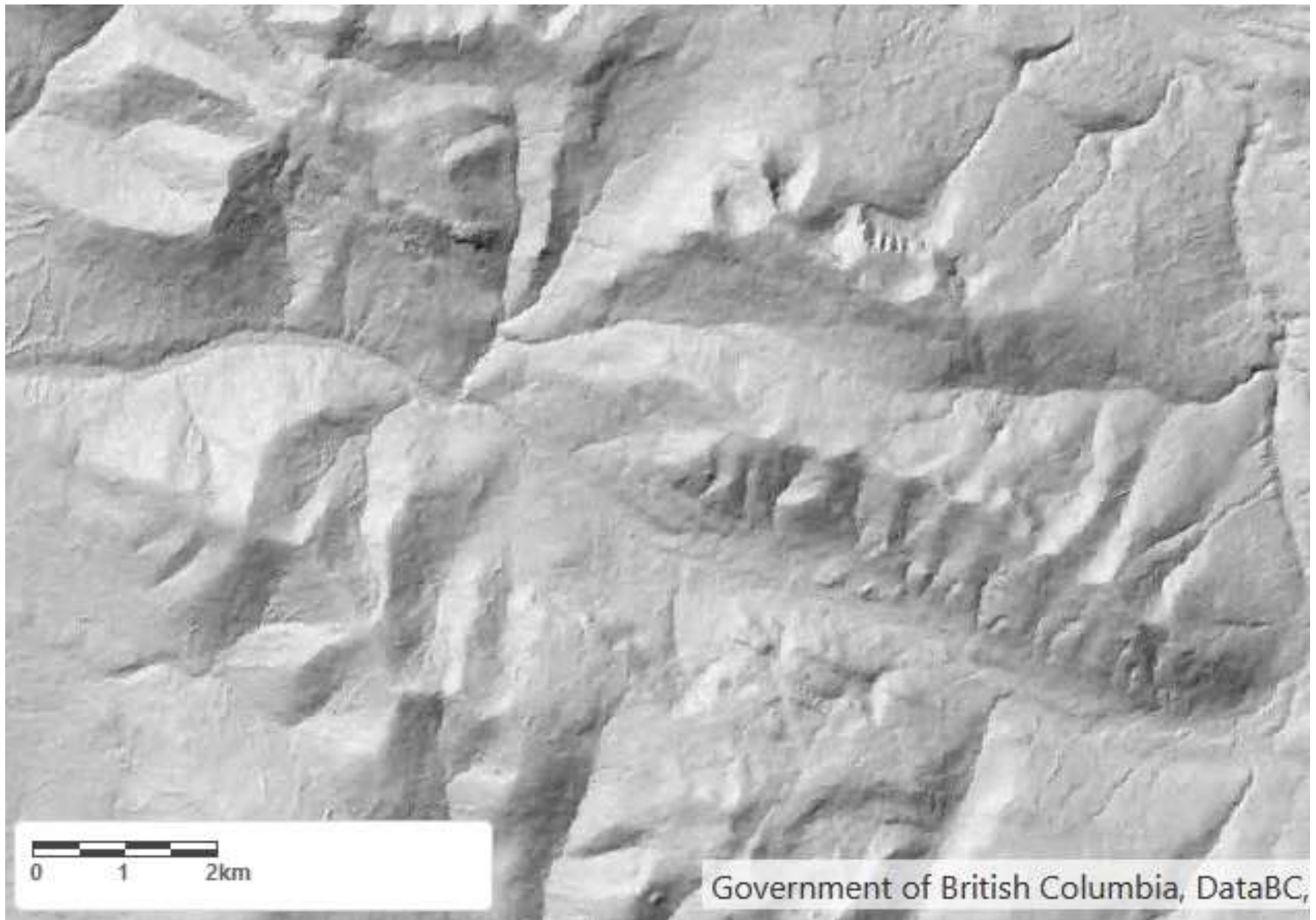The user selects azimuth / zenith **315 / 45 is** standard to match NW light source.

NEVER show hillshade layer in legend

… the numbers are meaningless

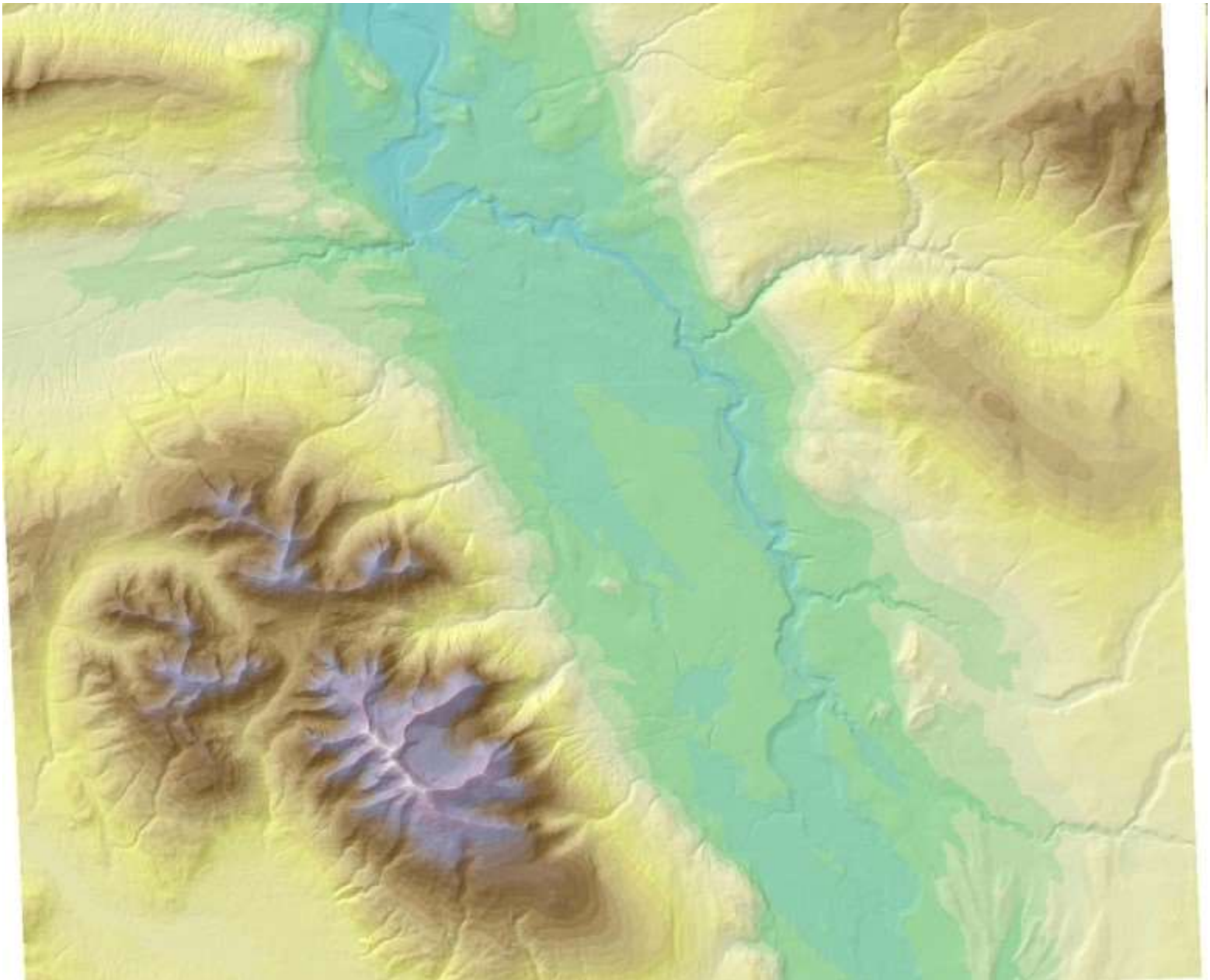**Manual shading: less common -100 hours / square foot (trained specialist)**

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

Using software <u>transparency</u> option to combine shading and tints

Routine
GIS
option

Shaded relief (hillshading) plus elevation tints
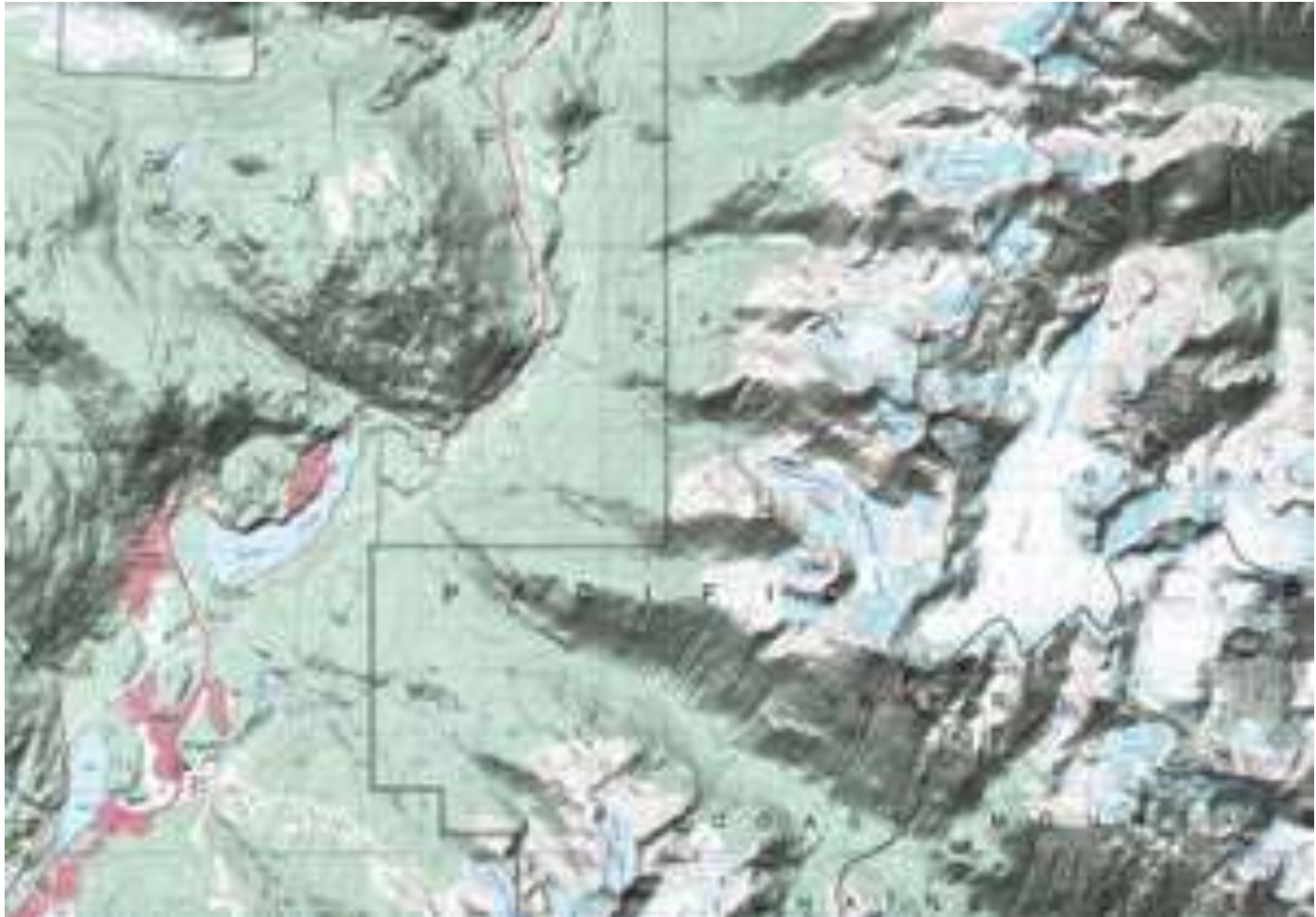
JLC Geomatique – addition of shaded relief

1/10000 Topographic Maps

NAD 83 / WGS 84   LAC ROSS   1/10 000

RÉSERVE FAUNIQUE DE PAPINEAU-LABELLE

Standard topographic map PLUS added hillshading – available for <u>all</u> Canada NTS maps
Value: easier visualisation of the landscape
http://gotrekkers.com
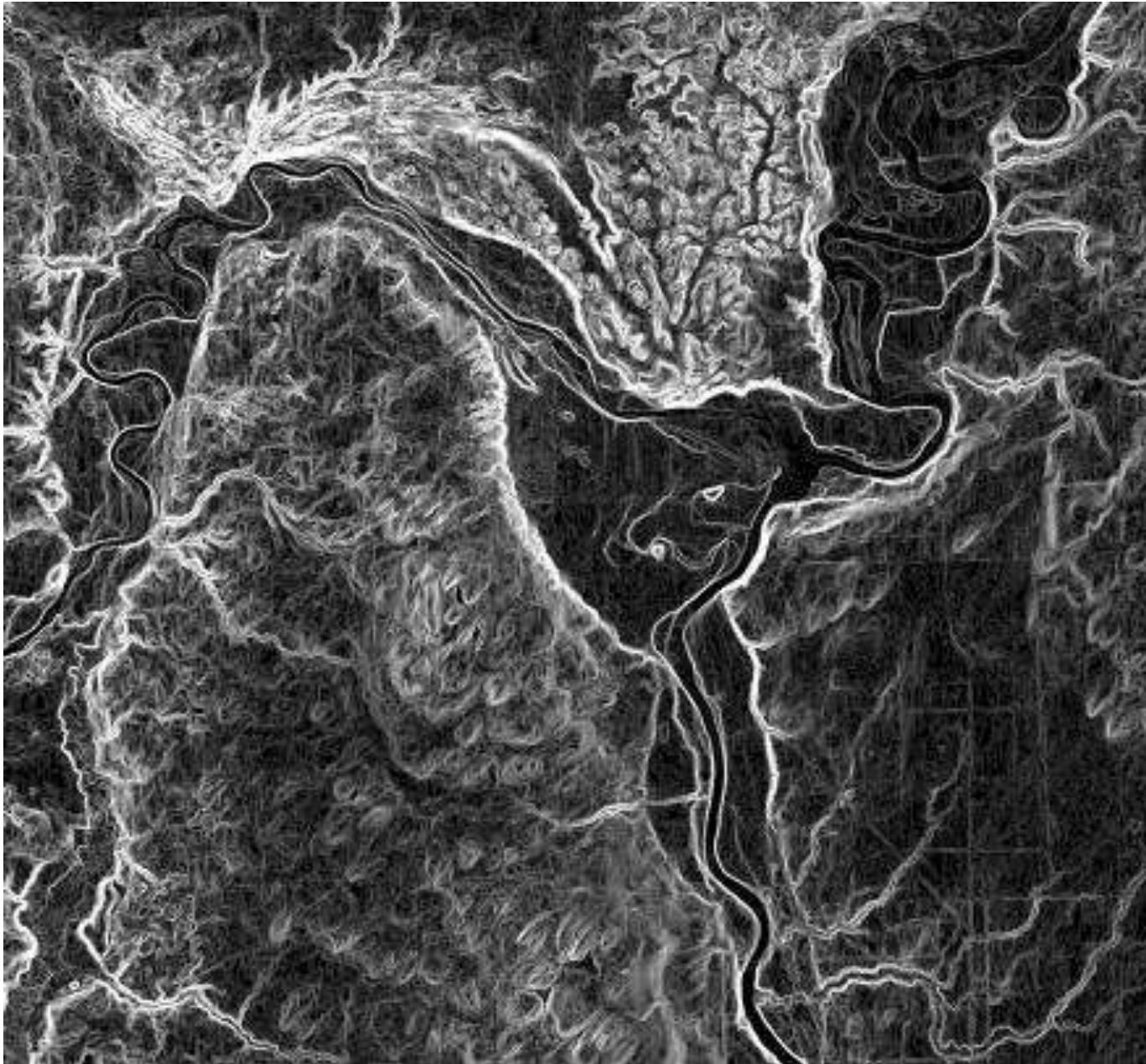
1:50,000,
1:250,000

7. Tanaka relief contours
– not a common software option

Tanaka contours – now an option in ArcGIS

ArcGIS Terrain Tools

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

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

Bright = steep

Dark = flat

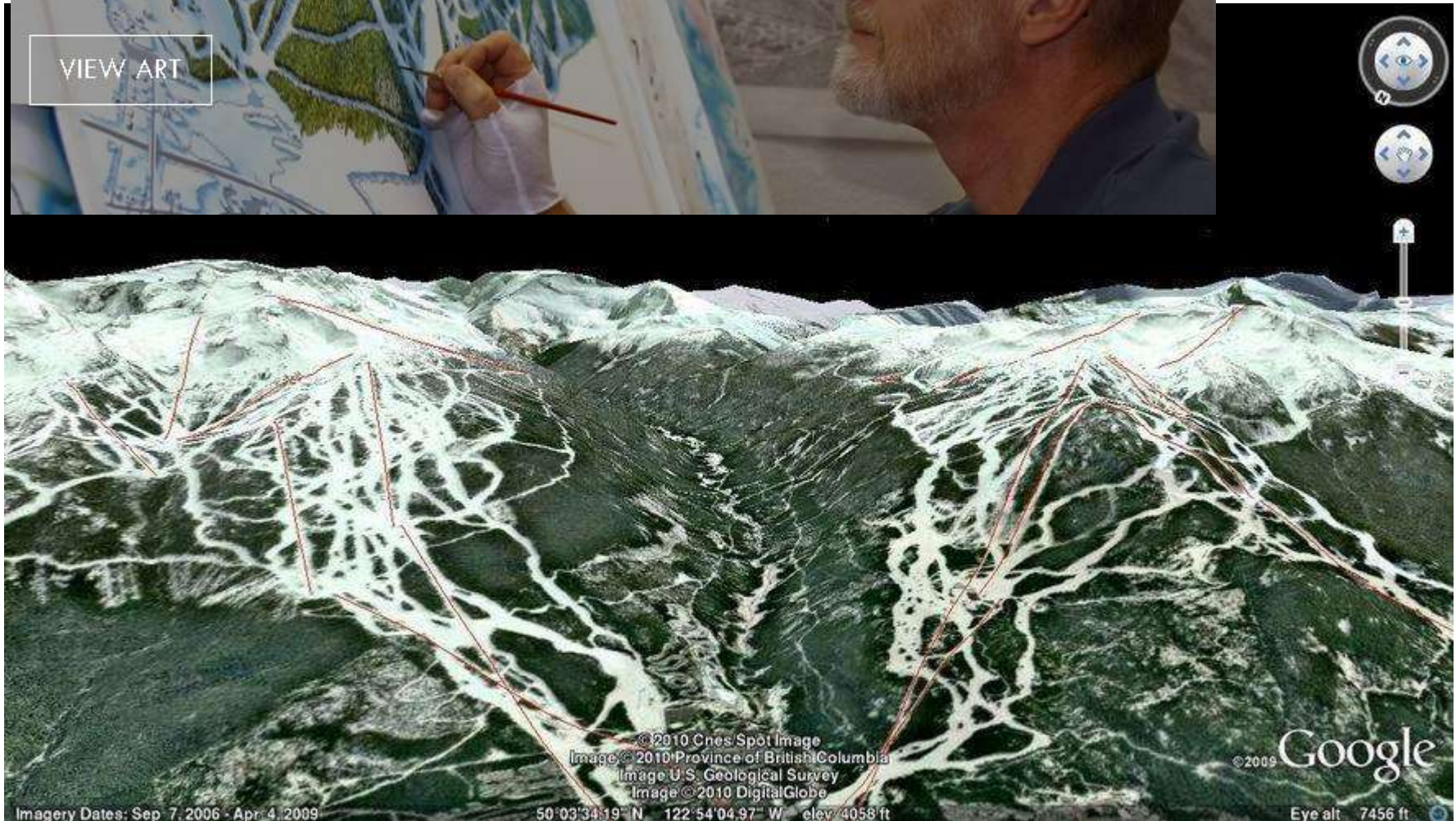# 9. (2.5D) **perspectives** (and flythroughs) – Google Earth, ArcScene

Estella Lakes

Tsay Keh Dene

User selects viewpoint, angle, vertical exaggeration, 'drape layers, e.g. labels, roads
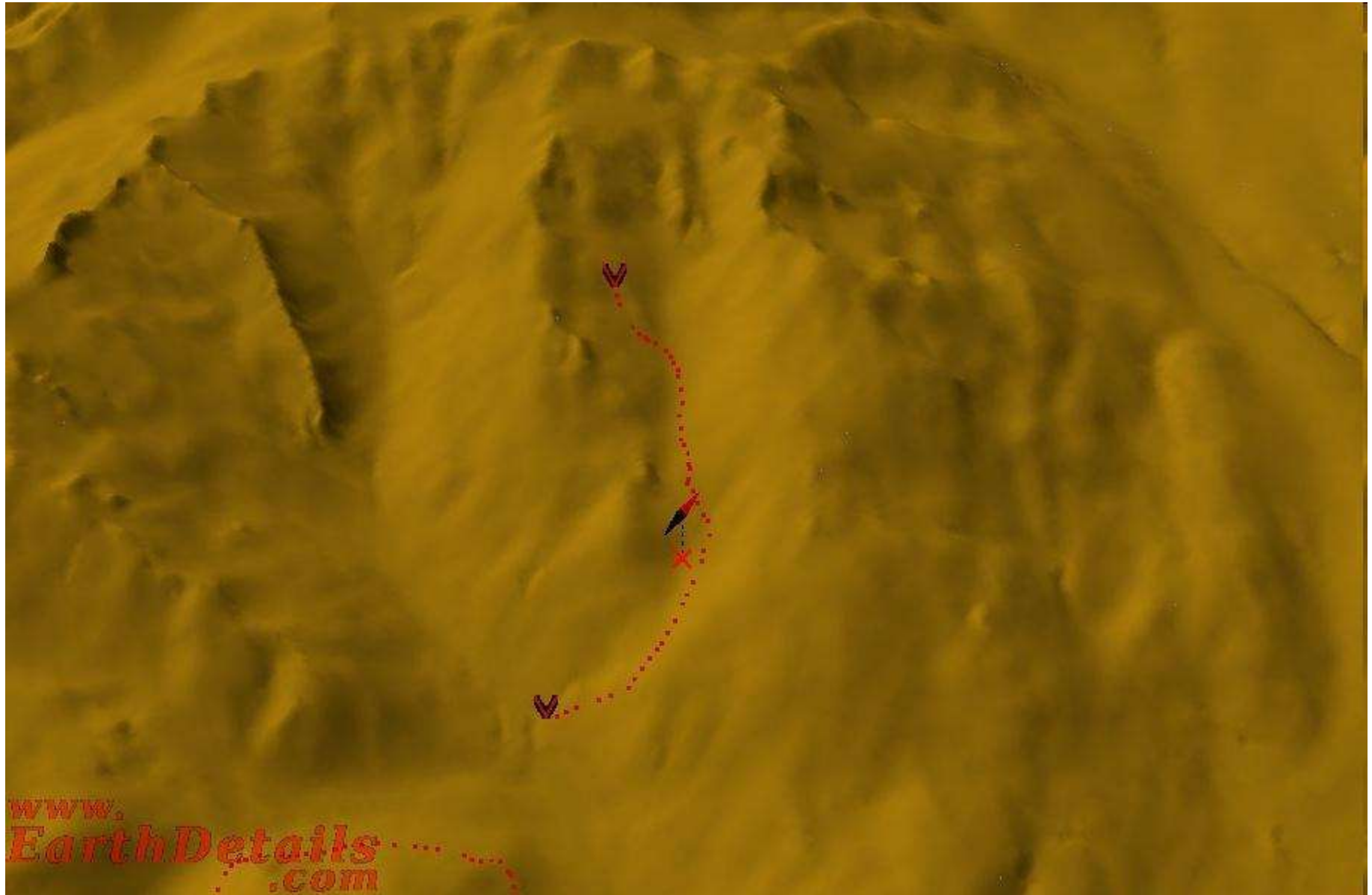
Plus "fly-through" animations

THE MAN BEHIND THE MAP

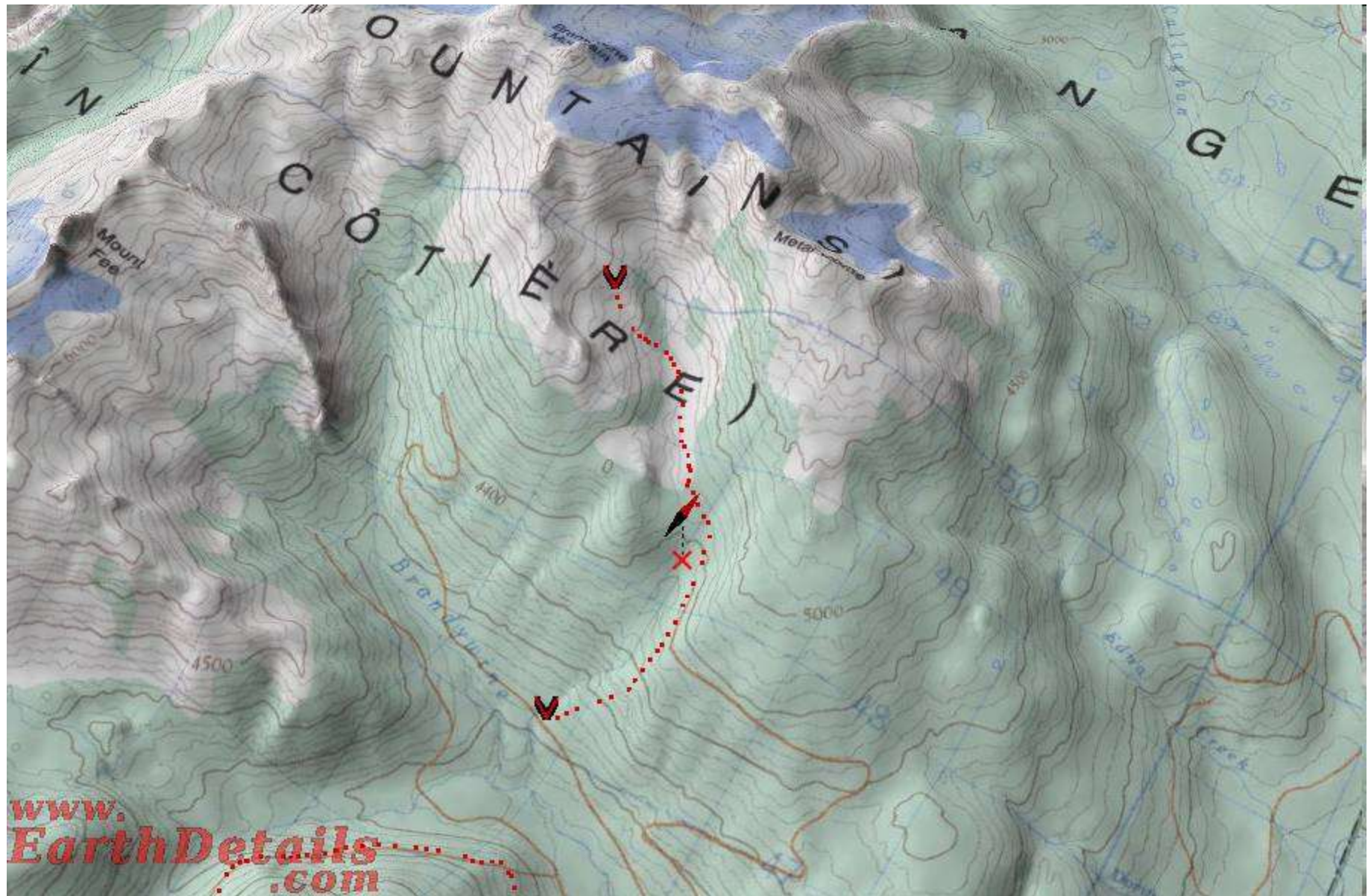Hand painted mountain maps by James Niehues

VIEW ART

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

9. 3D Perspectives

Whistler – Brandywine Meadows – with 'draped' NTS map

10. True 3D physical models

-40 x 74'
1:99,000)

-Solid
Terrain
Modelling
Cut by
laser

WORLD'S LARGEST PHYSICAL TERRAIN MODEL
IS THE CENTERPIECE OF THE NEW "BC EXPERIENCE"
GEOGRAPHIC DISCOVERY CENTER
IN VICTORIA'S HISTORIC CRYSTAL GARDEN

NOT !
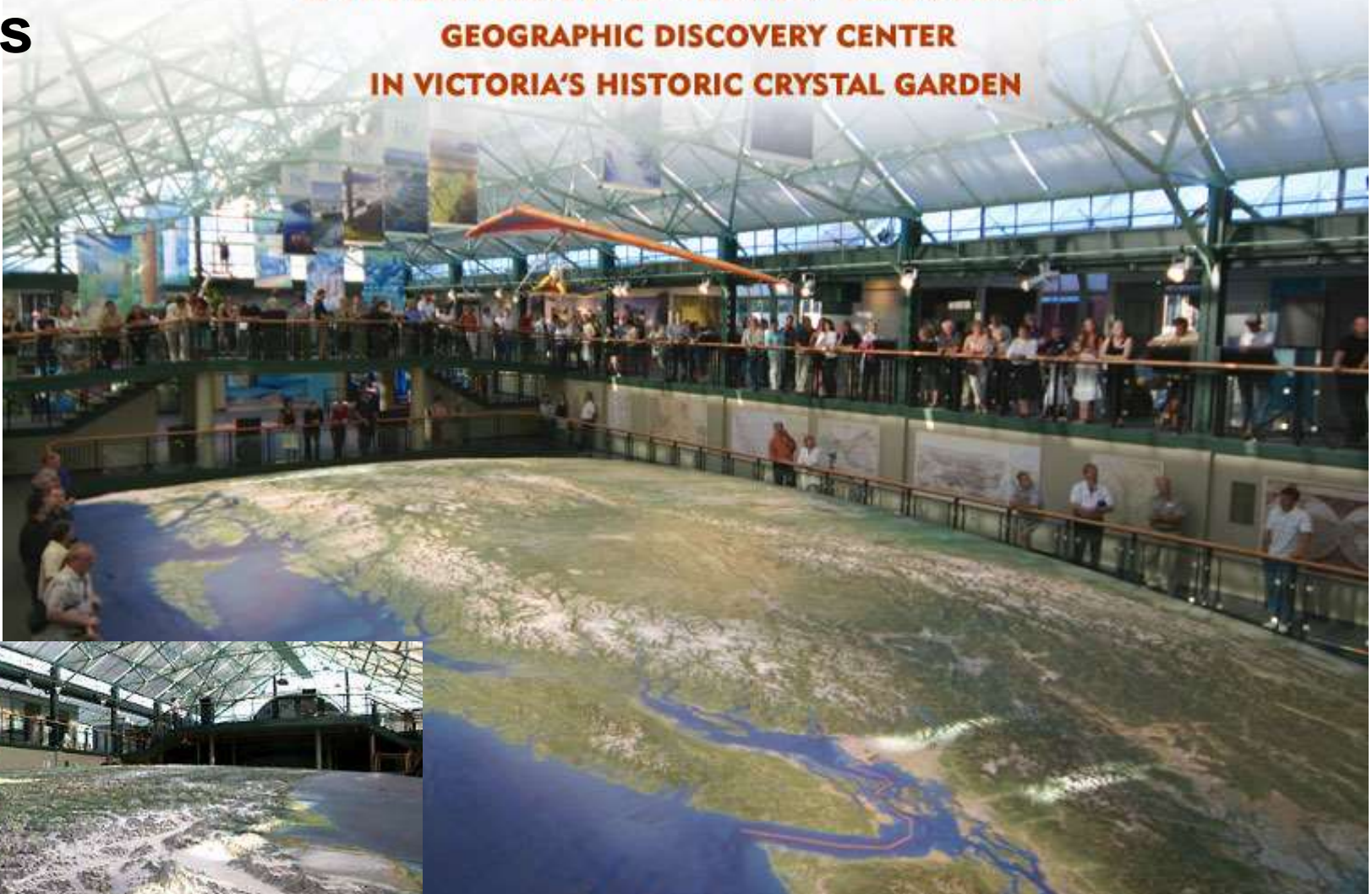
Note: Jack Challenger's BC wood map is 25 x 25m
Manually carved / created 1947-54, now in storage

Topographic Lake Map: Maple 12 x 24 $465

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

3d printer, Filaprint, Tumbler Ridge
http://www.filaprint.ca/

Jody Mitchell

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 – some made manually, modest change