Digital Elevation Models (DEM) How has relief depiction changed with DEMs /GIS ?

A DEM is a computer representation of elevation data to represent terrain



- And who built that road ~~~~~??

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



2. Hachures - not a common software option

show orientation of slope, and by their thickness and a general sense of steepness Only experimental in GIS / digital





Westfjords, Iceland

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



Contours are not DEMS, but can be used to create them ... Contours are 1-dimensional (length) ... with no info between the lines

Digital Elevation Models (DEMs)

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

The DEM holds 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 referred to (Europe) as Digital Terrain Models (DTM)



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

DEM creation methods A> by digitising contours (NTS maps -> NTDB layer) -Done for all of Canada (~1985-95)

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



DEM creation

- B. Digital stereo-grammetry: (e.g. BC TRIM 1980s)
- This is a smoother option, captured directly from aerial photographs
- stereo mass photos ->
- convert to raster GRID
- ArcGIS: 'topo to raster'



BC TRIM DEM 25m raster grid (1996)

Interpolated to 25m grid

In 1:250,000 map sheets

Vertical accuracy ± 10metres (sub-metre precision is useless)-

View on BC iMap

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



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

DEM (raster GRID) data

DEMs have been created at a variety of scales

Some 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	NTDR (Canada)	
A. Federal	1: 250,000	200	ivi DD (Canada)	
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

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



Prince George DEM (BC TRIM): higher elevation = brighter tone



The DEM is used to create tints or 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 <u>315 /</u> <u>45</u> standard to match NW light source.

NEVER show hillshade layer in legend

... the numbers are meaningless



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

Routine GIS option



Shaded relief (hillshading) plus elevation tints



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



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



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, not often as map layer



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

Bright = steep

Dark = flat

9. (2.5D) perspectives (and flythroughs) – Google Earth / GIS



Plus "fly-through" animations

Hand-drawn

(i))

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



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

10. True 3D physical models

-40 x 74' 1:99,000)

-Solid Terrain Modelling Cut by laser



IS THE CENTERPIECE OF THE NEW "BC EXPERIENCE" GEOGRAPHIC DISCOVERY CENTER IN VICTORIA'S HISTORIC CRYSTAL GARDEN

SECOND (2)



Note: Jack Challenger's BC wood map is 25 x 25m Manually carved / created 1947-54, now in storage

3d printer, Filaprint, Tumbler Ridge

http://www.filaprint.ca/



Jody Mitchell

How have DEMs inpacted 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)

Perspectives - greatest impact (visualisation)

True 3D models – still some made manually, modest change



True 3D models: Virtual reality sandbox (Eclipse Geomatics, Smithers BC)

https://www.youtube.com/watch?v=lqj4gxCE128