Topographic Map Enhancement: Kakwa Provincial Park, BC

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Figure 1: Mt. Ida

Abstract

Mountain cartography in Canada is challenged by limited human resources relative to a large land mass and in many areas, a limited number of potential users. The development of Geographic Information Systems (GIS) and the generation of digital data have enabled the design and production of some maps in the westernmost province of British Columbia (BC), without the high cost and training associated with manual hillshading. We illustrate the methodology, results and remaining challenges using the example of the newly established Kakwa Provincial Park in the Rocky Mountains.

1. Introduction

Mountain cartography is restricted by lack of human and financial resources relative to the large extent of the lightly populated mountain ranges of the western cordillera (composed primarily of the Rocky Mountains and the Coastal Mountains). While a limited number of sheets were produced using traditional photo-mechanical techniques prior to 1990, this was done only for test sections of the highest use areas, notably within Banff and Jasper National Parks, since manually creating hillshading was very time consuming and costly.

Large-scale well distributed maps of the western mountains are limited to the National Topographic Series (NTS) 1:50,000 maps which date back generally to about 1970, and depict terrain using only contours at 100 feet intervals. While the relief has usually not changed, river courses and glacier extents may have and anthropogenic features are quite outdated. The green colour used to depict forest cover symbolises areas where canopy cover exceeds 30%, and could be considered fairly generalised.

Since the late 1980s, the BC Ministry of Environment, Lands and Parks, through the Terrain Resource Inventory Management (TRIM) program, has generated digital map data at a scale of 1:20,000 for the whole province in tiles that measure 12’ longidtude by 6’ latitude: approximately 7000 map sheet tiles for the province, which are supplied in layers with DEM points, contours, toponymy and planimetric data. These ‘spaghetti’ data can be built and displayed as map layers and the DEM data used to generate shaded relief models. A second generation of TRIM data (TRIM II) as an update was commenced in 1997 and should be completed by 2005.

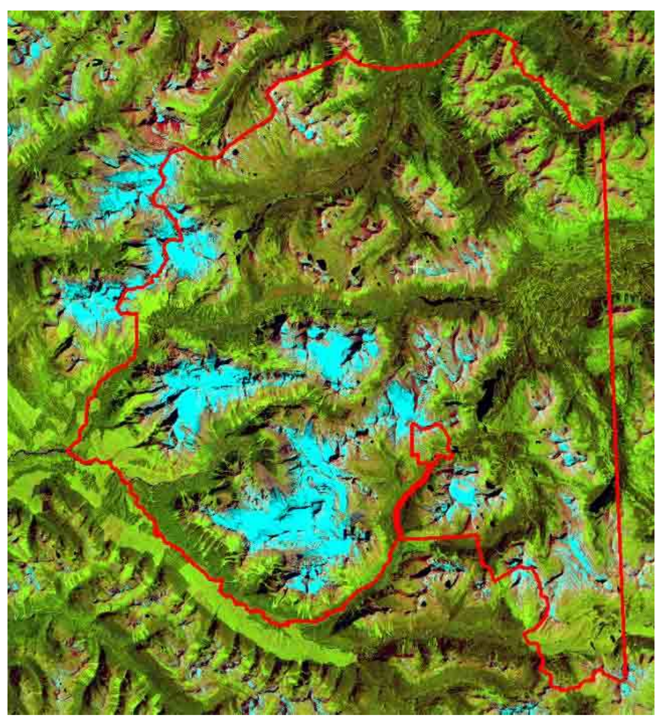
2. Study area

Kakwa Provincial Park is located in the extreme eastern part of British Columbia adjacent to the border with Alberta and covers an area of 1710 square kilometres ('Kakwa' means porcupine in the Cree language). It was designated a park in 2000 and forms part of the Rocky Mountain chain of mostly undeveloped wilderness extending northwest into northern BC beyond the Banff and Jasper National Parks to the southeast. However access to the park is via loosely maintained gravel roads which end before the park and require further travel foot (12 km from the BC side) by bicycle, horse or snowmobile (in winter). These gravel roads extend either along 80 km from the south from highway 16 connecting Prince George and Jasper, or to the northeast to Grand Prairie. As a result, users are limited to approximately 150 in summer and an unmonitored estimate of 300 in winter (unofficial estimates; Jean-Guy Bergeron).

The park contains typical Rocky Mountain scenery with numerous glaciers, lakes, alpine meadows and forested valleys (elevation down to 800m). The two main peaks are Mt. Sir Alexander (3274m) and Mt. Ida (3180m), the latter a classic pyramidal peak similar to Matterhorn and Assiniboine but seen by very few visitors other than from a remote distance. As a new park, local users and residents are concerned as to any future development plans. An introductory guide and description of the park was the subject of a UNBC Masters project (Bergeron, 2001).

Figure 2: Location in British Columbia

Figure 3: Landsat Image of Kakwa



20 Km

3. Data sources

Existing maps of the area are limited to portions of six 1:50,000 NTS map sheets in two 1:250,000 areas (93H and 93I); these were compiled from aerial photography between 1961-75. BC TRIM data are available at 1:20,000 for these layers, with different types of features separable by an 'fcode' attribute.

a. Planimetric layers depicting: hydrography (lakes, rivers, marshes, glacier outlines and point feature locations such as waterfalls and rapids), roads (gravel only in this area), treeline, and cultural point and line features such as cabins, powerlines etc.. which are limited in this area.
b. Toponymy: place names are incomplete since many names are undecided in this area
c. contour lines (20 metre interval)
d. DEM points, sampled approximately at 70 metres spacing

When TRIM II data arrived, DEMs could also be acquired as 25 metre raster grids interpolated from the points. Planimetric data have been separated into feature layers (roads, rivers etc..).

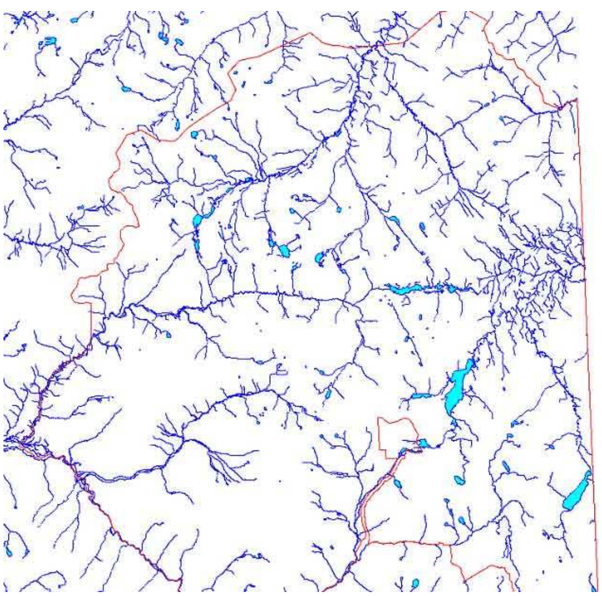


Figure 4: TRIM Hydrography

FCODE	DESCRIPTION
GA03950000	Canal
GA08450000	Dam
GA08450110	Beaver Dam
GA08800110	Ditch
GA10450000	Falls
GA11500000	Flume
GA23500000	Rapids
GA24850000	River / Stream
GA24850130	River / Stream (Dry)
GA24850140	River / Stream (Indefinite)
GA24850150	River / Stream (Intermittent)
GA28550000	Spillway
GA90000110	River / Stream (Left Bank)

Figure 5: Feature Codes

4. Data processing

a. Cleaning linework

Vector lines were cleaned and built to create lakes and marshes as polygons and to reduce the number of arc segments for rivers and contour lines. The cases of glaciers and forest (versus non-forest) represent further challenges as the latter are captured only as line vectors, and hence it is unclear for any polygon whether each side is forested or unforested. The same is true of more complex glaciers involving interior bare rock; in addition TRIM outlines have been observed to be less than reliable since early summer photography results in significant remnant snow patches that conceal glacier edges.

b. Generating vectors from satellite imagery

These two challenges were met using image processing of a cloud-free Landsat 5 Thematic Mapper image dataset from September 1994. Band ratios were employed to enhance both glacier edges and vegetation changes: a 4/5 ratio and a 4/3 ratio respectively, which enabled us to generate new vectors, and could be built into polygons for glaciers and forested areas respectively. We are continuing to refine this process and to work with later Landsat imagery to monitor changes due to glacier retreat and avalanches. These satellite images are also useful for providing 3D perspectives for landscape visualization.

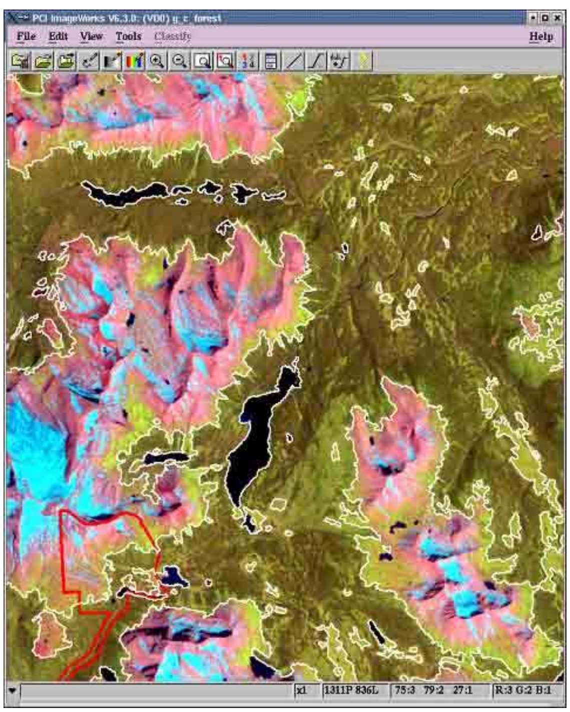


Figure 6: Non-forested/Forested Image

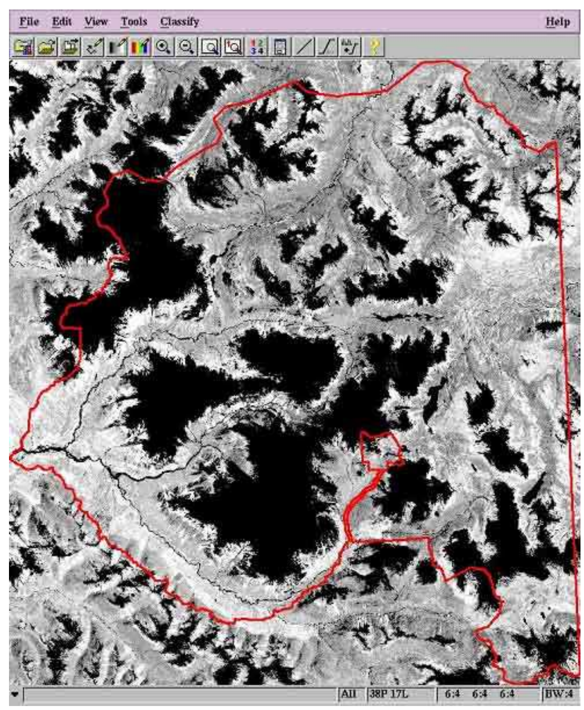


Figure 7: Treeline overlain on Landsat

c. Additional (new) vectors

TRIM did not include the park boundary which was established only in 2000; however those for all BC Parks are available from the BC Parks website for download in export format. Trails and routes are mostly unmapped and in fact unmarked due to the undeveloped nature of the park. These were added by digitizing from topographic memory (Bergeron, 2001) with intent to map them more accurately by GPS in coming summers.

d. Integration of hillshading and thematic layers

Hillshading was generated from the DEM; some artefacts are apparent on some glacier areas, as a result of inadequate point capture due to reflectance saturation from the bright surface (Sidjak and Wheate, 1999). We hope to be able to incorporate data from other sensors such as ASTER to compensate for these. Since experiments with photo-mechanical combination of hillshading and forest cover in the 1970s, it has become commonplace to use GIS software to perform this in research mapping, even if not in mass production. In this case, we integrated both glaciers and forest cover with the hillshading, rather than overlaying or printing these layers separately.

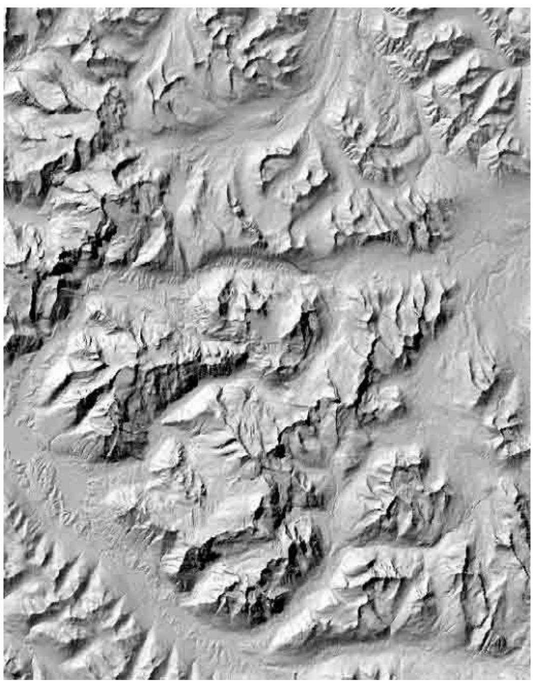


Figure 8: Gray Scale Hillshading

Figure 9: Hillshading merged with forest cover and glaciers.

e. Labelling

As a starting point, we incorporated in some cases an auto-labelling function utilising a name attribute associated with each label point. However in other cases, we needed to add lettering for new and in some cases unnamed peaks and passes. Labelling of contours posed further challenges in this regard as the software default labelled each arc segment with the elevation value. This was qualified to restrict labelling first to index contours, and second to only segments exceeding a selected threshold length, to minimise repetition along the same contour but at the same time retain labels on smaller 'island' contours.

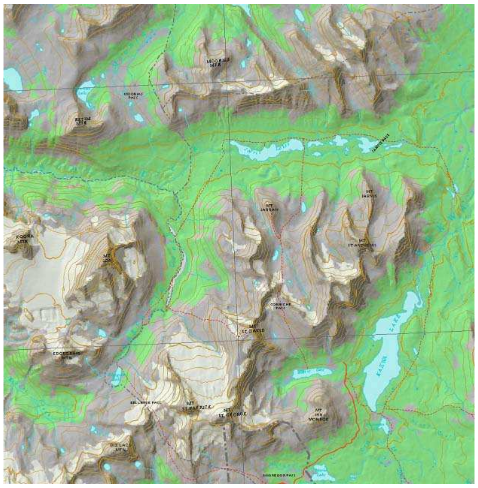


Figure 10: Map Sample

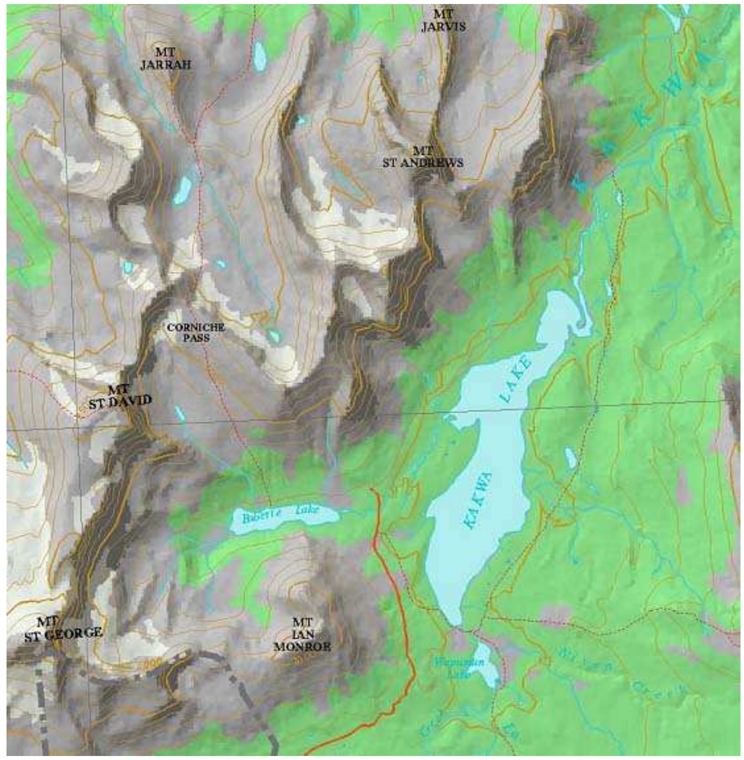


Figure 11: Kakwa Lake Area

5. Summary and Conclusions

Specialised mountain cartography is limited in western Canada to a small number of map producers and mapping resources. However the province of British Columbia which includes the majority of the western cordillera, is well covered by digital data, which can be cleaned and augmented with linework derived from recent satellite imagery where necessary. The known advantages of shaded relief can be incorporated into mountain map design without the traditional problems of cost and need for scarce practitioners. The quality of GIS derived maps however may not yet match the best traditional cartography that was achieved previously (Henoch and Croziet, 1976): this remains our lofty goal.

6. Future work

The Kakwa map is in process of completion but still awaits route verification by GPS. It will be a prototype for examples of mountain cartography in northern British Columbia. The entire length of the Rocky Mountain Range northwest of Jasper National Park are covered only by National Topographic map sheets which are more than 25 years out of date. The Northern Rockies (Muskwa-Kechika) alone is 1.5 times the size of Switzerland.

Figure 12: Kakwa Lake and Babette Lake

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Henoch, W.E.S. and Croizet, J.L. 1976, The Peyto Glacier Map : A three-dimensional depiction of mountain relief, *The Canadian Cartographer*, 13 No.1, June 1976, 69-86.
Sidjak, R.W. and Wheate, R.D.*, 1999.* "Glacier mapping of the Illecillewaet Icefield, British Columbia, Canada, using Landsat TM and digital elevation data”, *International Journal of Remote Sensing,* Vol 20, No.2, 273-284
Kakwa Provincial Park: *wlapwww.gov.bc.ca/bcparks/parkpgs/kakwa.htm*