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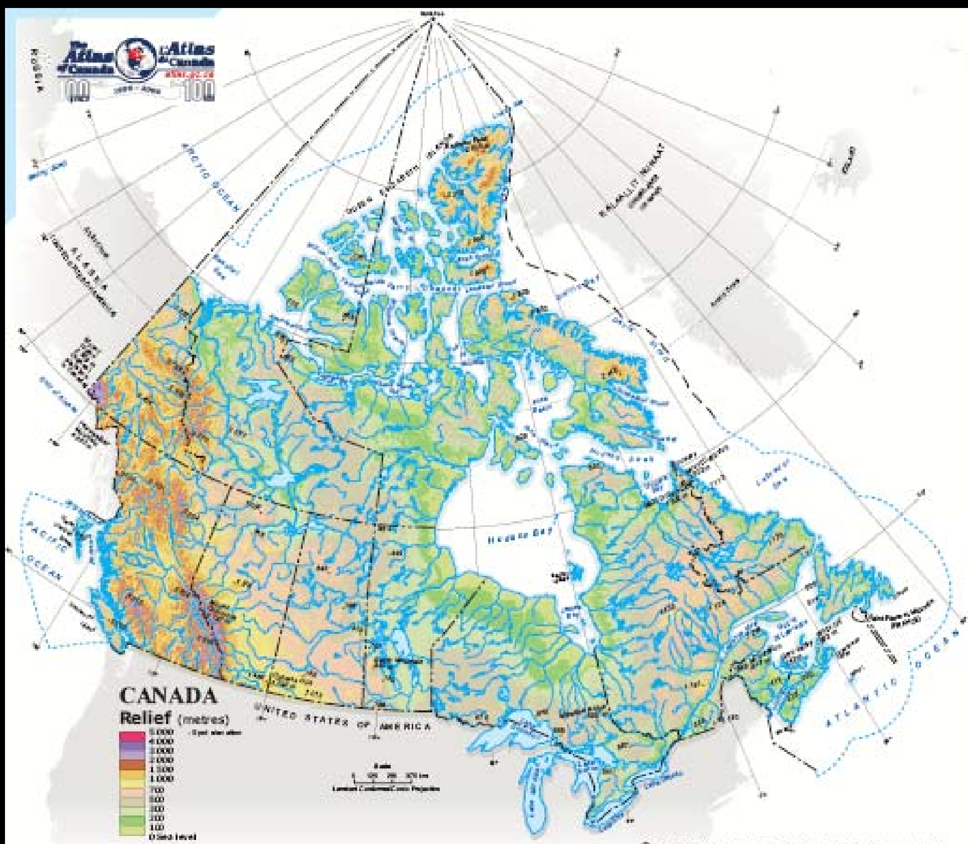
Outline

The Global Soil Map Project

Canada’s Contribution to GSM

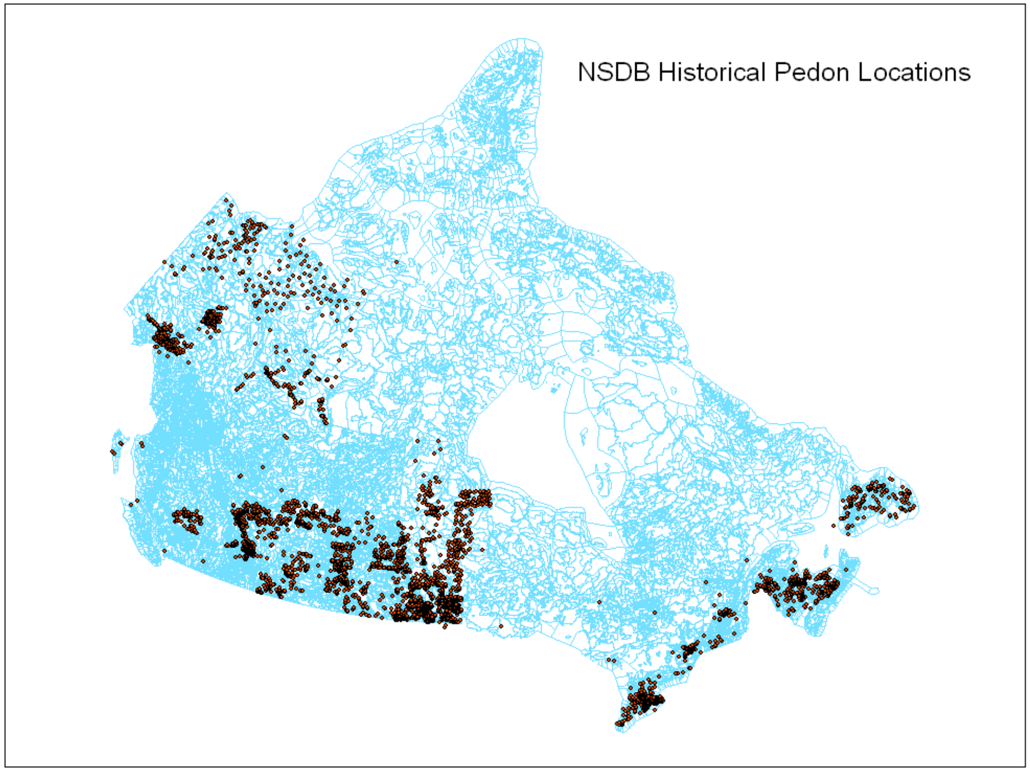
Canada – USA Pilot Study

Digital Soil Map - North American Node

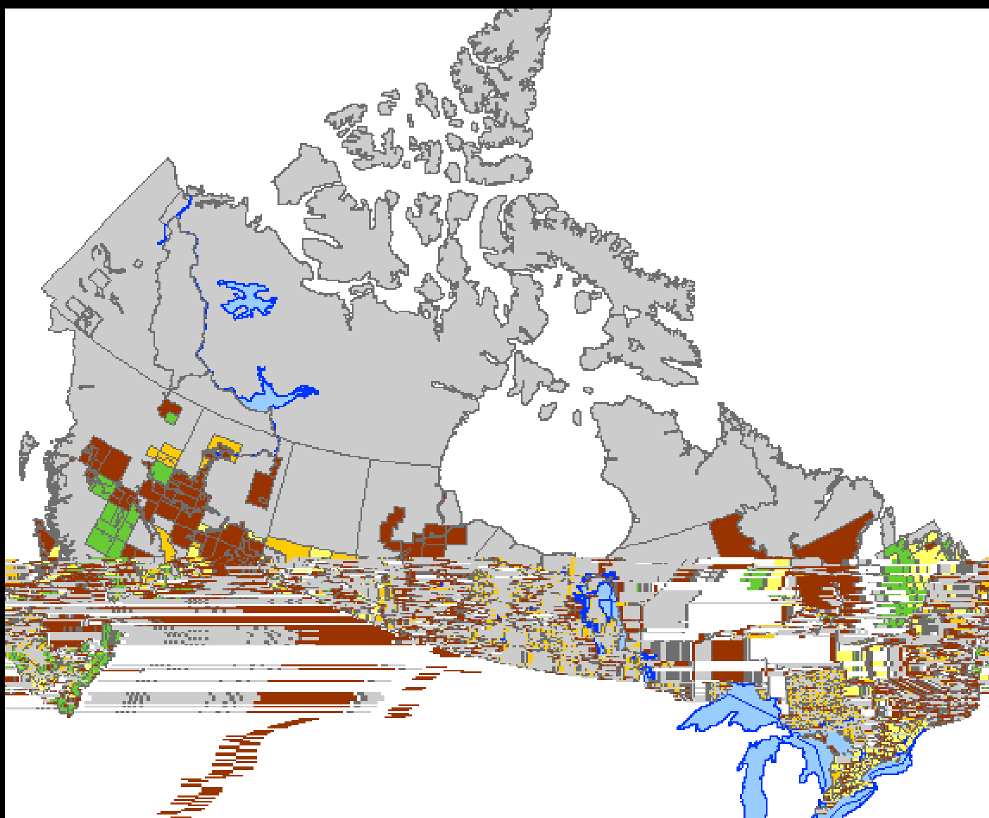


CANADA
Relief (metres)
5 000
4 000
3 000
2 000
1 500
1 000
700
500
300
200
100
0 Sea level
UNITED STATES OF AMERICA
Hudson Bay
PACIFIC OCEAN
ATLANTIC OCEAN
ARCTIC OCEAN

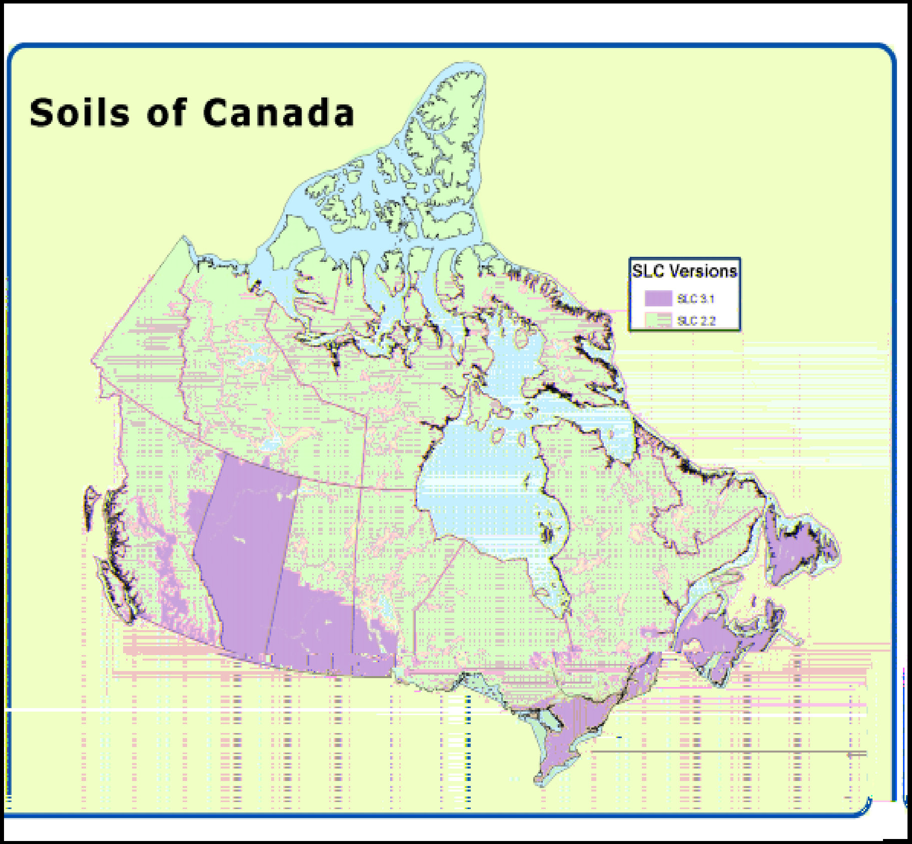
Pedon Samples in the Canadian Soil Data Base



Detailed Canadian Soil Maps

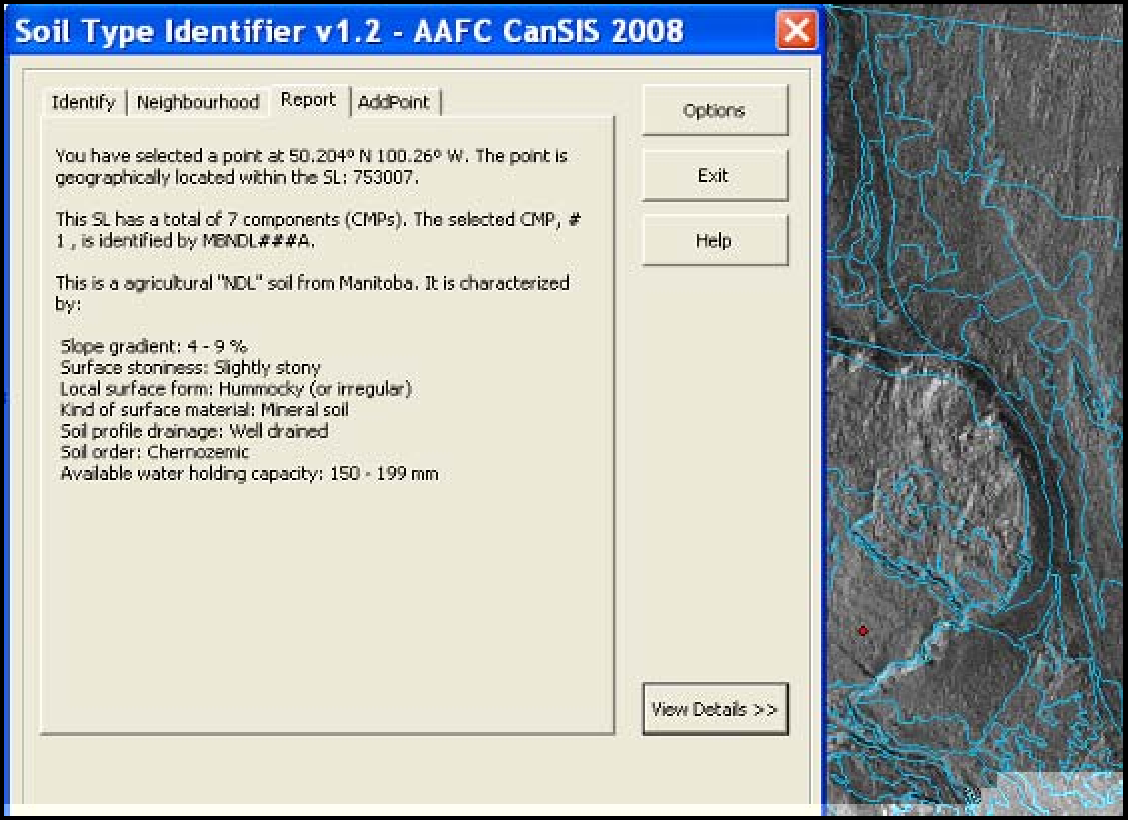


Soil Landscapes of Canada (SLC) – Version 3



Older Soil Landscapes of Canada (SLC) maps, such as SLC version 2.2, provide national coverage, but

Soil Survey Knowledge Data Mining Tool



Canada - USA Pilot Study Area Selection Criteria:

Northern Glaciated Plains Digital Soil Map Test Area

Canada - Aspen Parkland and Southwest Manitoba Uplands Ecoregions

USA - Northern Black Glaciated Plains Major Land Resource Area (MLRA 55A)

Area: approx. 6,225 km^2 (622,400 hectares)

Northern Glaciated Plains Case Study - Objectives:

Northern Glaciated Plains - Proposed DSM Map Layers

Primary Soil Attributes (from US / Canadian soil data files)

Inferred Soil Attributes (from pedo-transfer functions)

- Plant available water capacity
- Nutrient supply capacity (CEC, exchangeable bases, available P)
- Infiltration / Permeability
- Salinity/ risk of salinization

Soil bulk density derived from detailed soil map data

Bulk Density:
First mineral horizon, weighted by map unit composition

Source:
1:12,000-1:40,000 scale digital soil map data

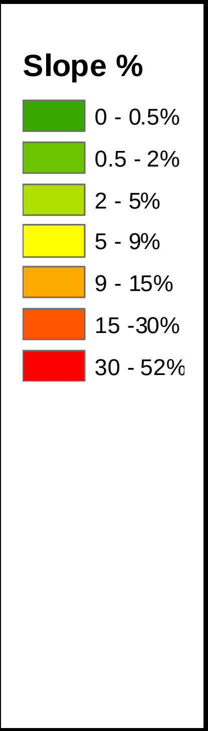
Resolution:
10 meters

Northern Glaciated Plains Study Area – Enhancements to the 90m SRTM coverage

SRTM data is available for the USA at 30m resolution, but limited to 90m for the rest of the world. 30m data has 9 times the number of digital elevation values.

Canadian researchers are investigating methods of enhancing the 90m raster product for predictive Digital Soil Mapping applications

Several methods are being investigated to “up sample” the standard 90m global SRTM data to produce higher resolution 30m DEM products for Canada. A slope map of the Canada-USA study area derived from the standard 90m SRTM (Canada) versus 30m (USA) is shown on the left. The same area, with the Canadian portion resampled by cubic convolution to 30m, is shown on the right. Cubic convolution is a raster based interpolation algorithm that calculates the weighted average of 16 of the nearest input cell centres.



Standard 90m STRM (Canada) versus 30m (USA)

Enhanced 90m resampled to 30m (Canada) versus 30m (USA)

Statistical comparisons can also be used to evaluate DEM attributes derived from standard 90m global SRTM data versus results from “up sampling” methods. The histograms below show the range in slope values based on a 30m pixel to pixel comparison between the SRTM 30m and SRTM 90m (graph on the left) and the SRTM 30m and SRTM 90m resampled to 30m (graph on the right). As illustrated, there is a significant improvement in the resampled SRTM 90m data since the differences in slope values primarily occur in the 0-1% slope class, while the same values in the SRTM 90m occur in the steeper classes.

Standard 90m STRM (Canada) versus 30m (USA)

Enhanced 90m resampled to 30m (Canada) versus 30m (USA)

Three dimensional views can also be generated to compare digital elevation model results. These examples both show the Turtle Mountain Upland portion of the Canada - USA study area with slope classes for each pixel draped over the DEM.

The 30m derived slope map (right) has significantly more pixels with <5% slope, and provides a better representation of the slopes in the study area.

Conclusions

Digital map of soil organic carbon ($g\ m^{-2}$) derived from legacy data

SSURGO:

$SOC_{0\text{-}20}$ = Organic Matter (g/100 g soil) * 0.58† * 0.01‡ * 1/3 bar Bulk Density ($g\ cm^{-3}$) * 1,000,000§ * Horizon Thickness (m) * Rock Fragment Conversion Factor$^{\ell}$

DSS:

$SOC_{0\text{-}20}$ = Organic Carbon (g/100 g soil) * 0.01‡ * Bulk Density ($g\ cm^{-3}$) * 1,000,000§ * Horizon Thickness (m) * (1-[$Vol_{coarse\ fragments}$ /100])

† Conversion factor between organic matter and organic carbon

‡ Conversion factor from g SOC/100 g soil to g SOC/g soil

§ Conversion factor from g SOC cm^{-3} soil to g SOC m^{-3}

$^{\ell}$ RFCF is used to adjust for the volume of rocks in a soil sample.

$^{\ell}$ RFCF = (Mass < 2mm fraction * 1/3 bar *Pb*) / [(Mass < 2mm fraction * 1/3 bar *Pb*) + (1 – Mass < 2mm fraction)/2.65 g cm^{-3}]

Bliss, N.B., S.W. Waltman, and G.W. Peterson. 1995. Preparing a soil carbon inventory of the United States using geographic information systems.p. 275-295. In R. Lal, J. Kimble, E. Levine, and B.A. Stewart (Eds) Soils and Global Change. CRC Press, Boca Raton, Florida, USA.

Issues

- SRTM data availability and alternatives
- DSM methods less reliant on terrain model derivatives
- Data harmonization
  - Cartographic and taxonomic
- Mapping inconsistencies
  - Within country and between countries
- Soil properties with depth
  - Taxonomic horizons vs. layers
- Consistency of node DSM methodologies
- Future trans-national collaborations of NA GSM node:
  - Mexico, Central America, Caribbean
- Consortium-wide DSM training and mapping activities