Food and Agriculture Organization of the United Nations

10 June 2022

State of Black Soils in Canada

Launch of the

International Research Institution of Black Soils

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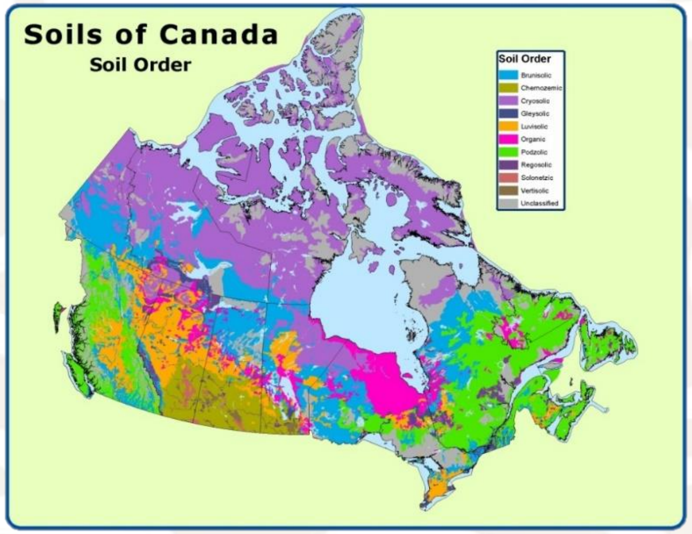
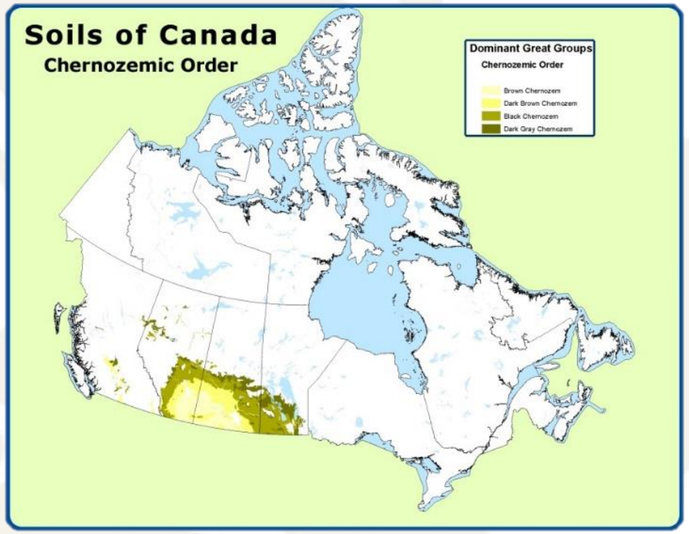
Mollisols/Chernozmic soils in Canada





Mollisols are extensive in sub-humid to semi-arid areas on the plains of North America, Europe, Asia, and South America.

According to the Soil Taxonomy (1999), Mollisols should have Mollic Epipedon.
The thickness of the Mollic Epipedon depends on the depth and texture of the soil is at least equal or above 10cm deep.

According to the Canadian Soil Classification System (1988), Chernozemic soils are dominant in the grassland regions of Canada including the great expanse of the Canadian Prairies. Ah or Ap horizon of Chernozemic soils should be above 10cm while meeting other criteria.

Characteristics of black soils in Canada

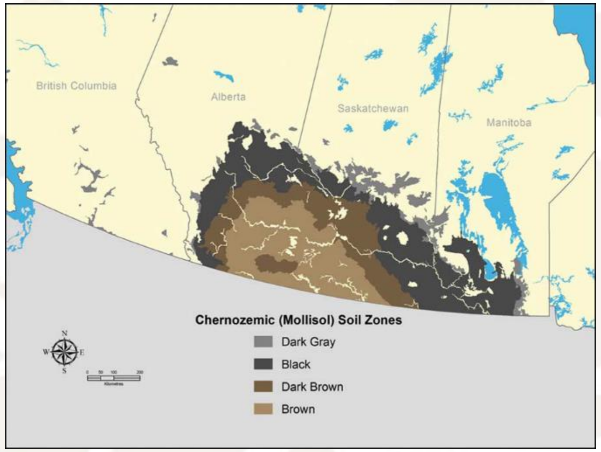


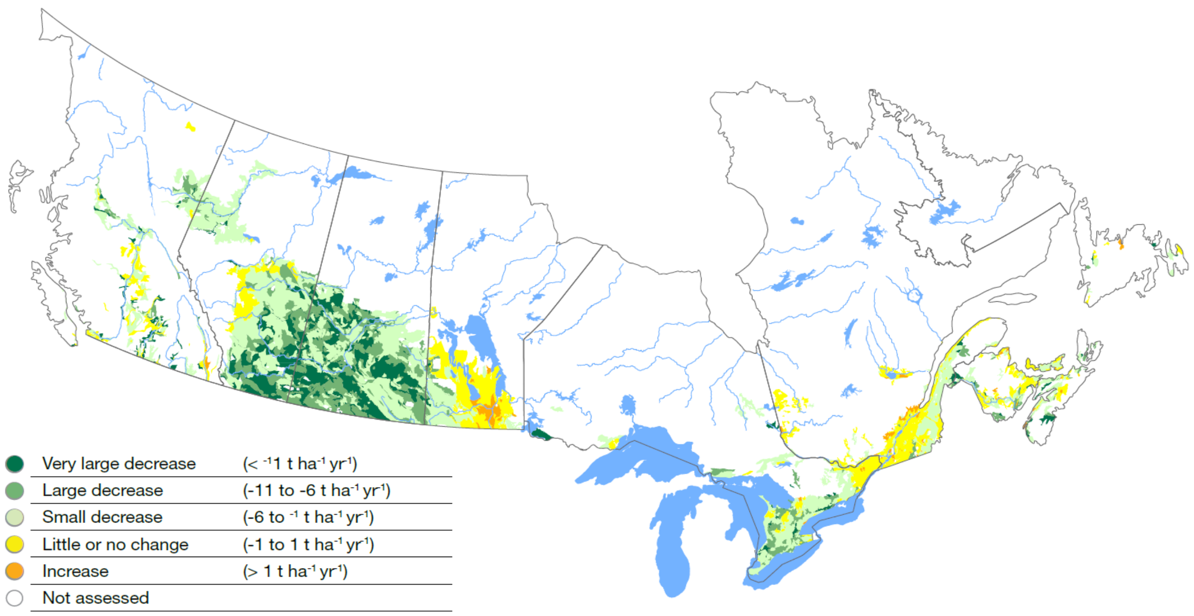
Table 1. Descriptive characteristics of Chernozemic soil zones in Canada

	Chernozemic soil zone			
	Brown	Dark Brown	Black	Dark Gray
Land area (km^2)	116 986	91 921	208 365	40 224
Soil climate	Boreal, sub-arid;	Boreal semi-arid;	Cryoboreal sub-humid;	Cryoboreal, sub-humid to humid
Average annual precipitation (mm)	275–325	325–425	425–475	300–500
Mean annual water deficit (cm)	19–38	13–19	6.5–13	6.5–13
Dominant native vegetation	Short and mid-grass prairie	Mid-grass prairie	Aspen parkland	Aspen parkland to mixedwood forest
Soil organic matter (%)	2.5–3.4	3.5–5	5–8.5	3.5–5.5
Soil pH	<6.0 to >7.5	6.0–7.8	6.0–7.5	<5.0–7.5
Main soil type	Medium-textured loam; some coarse sand	Medium-textured loams; some clay and sand	Medium-textured loams; some coarse sand and fine clay	Medium-textured loams

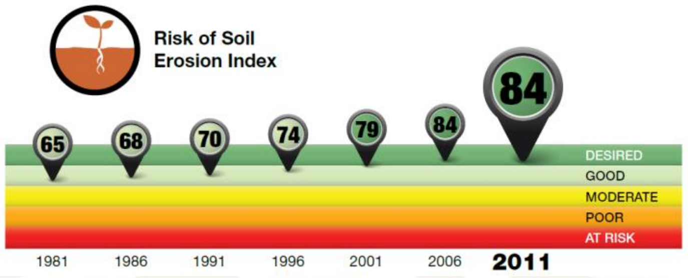
Huffman, T., Coote, D. R. and Green, M. 2012. Twenty-five years of changes in soil cover on Canadian Chernozemic (Mollisol) soils, and the impact on the risk of soil degradation. Can. J. Soil Sci. 92: 471479.

Reduced soil erosion due to BMPs

Soil Erosion – improvements in the Prairies due to soil improvement measures, slight decline in Eastern Canada related to shift to annual crops



Changes in agricultural land management practices in Western Canada, such as the extensive adoption of conservation tillage combined with reduced summer fallow and increasing crop yields which has, in turn, increased C input to soils, has resulted in an increase in net removals of CO2 from Cropland in the 1990–2006 period. This trend is further augmented by reductions in the conversion of other lands to Cropland over the same period. However, since 2006, a decrease in the adoption rate of conservation tillage, the conversion of perennial lands to annual crop production and, in recent years, some increases in the conversion of Forest Land and Grassland to Cropland has resulted in a levelling off and decline in Cropland removals.



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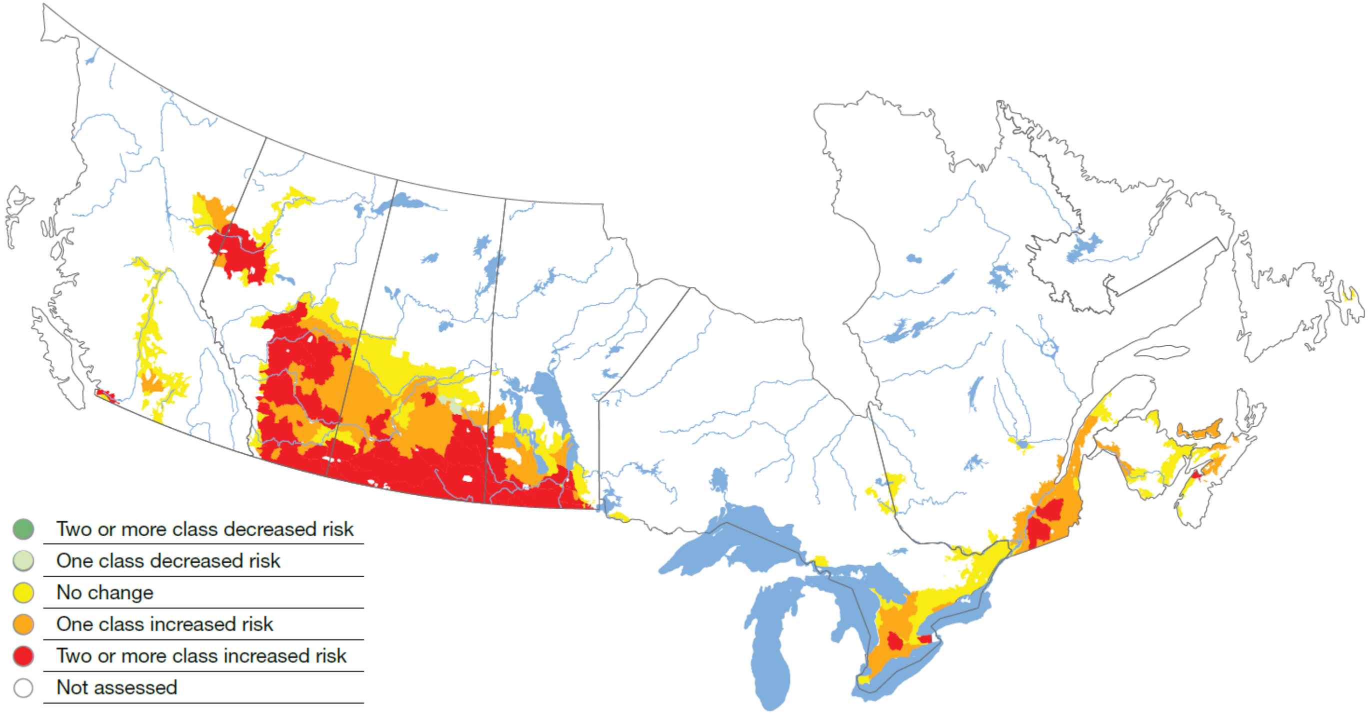
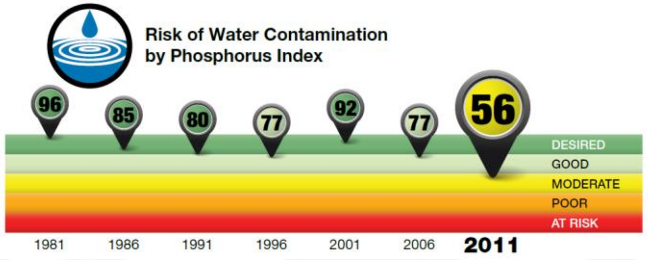
Water quality indicators - Phosphorus

Phosphorus – large increase in risk between 1981 and 2011, due to increased fertilizer use and wet weather

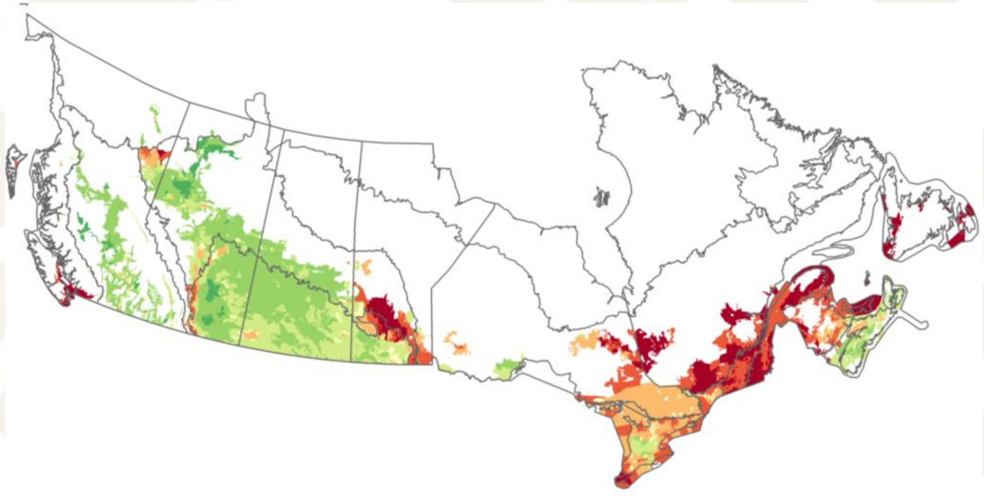


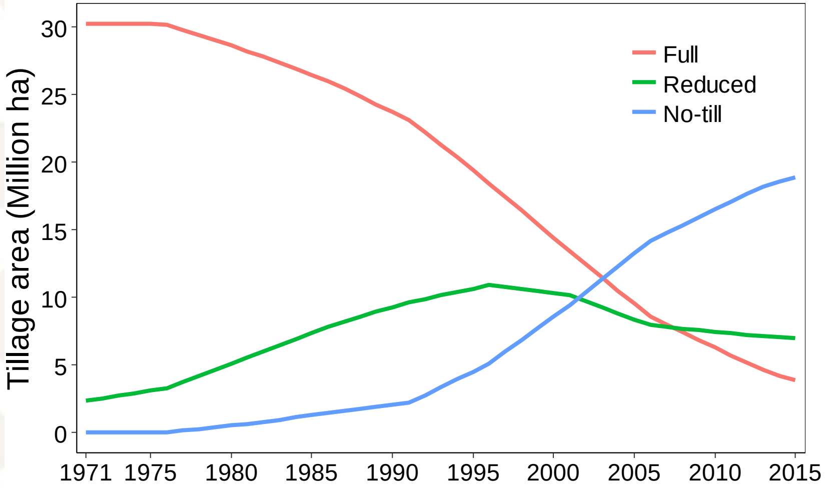


Map of SOC change across Canada

No-till now predominant

Main opportunity now to convert more full- to reduced-till





SOC change rate (kg C/ha/yr)

-300 -100 -10 0 10 100 300

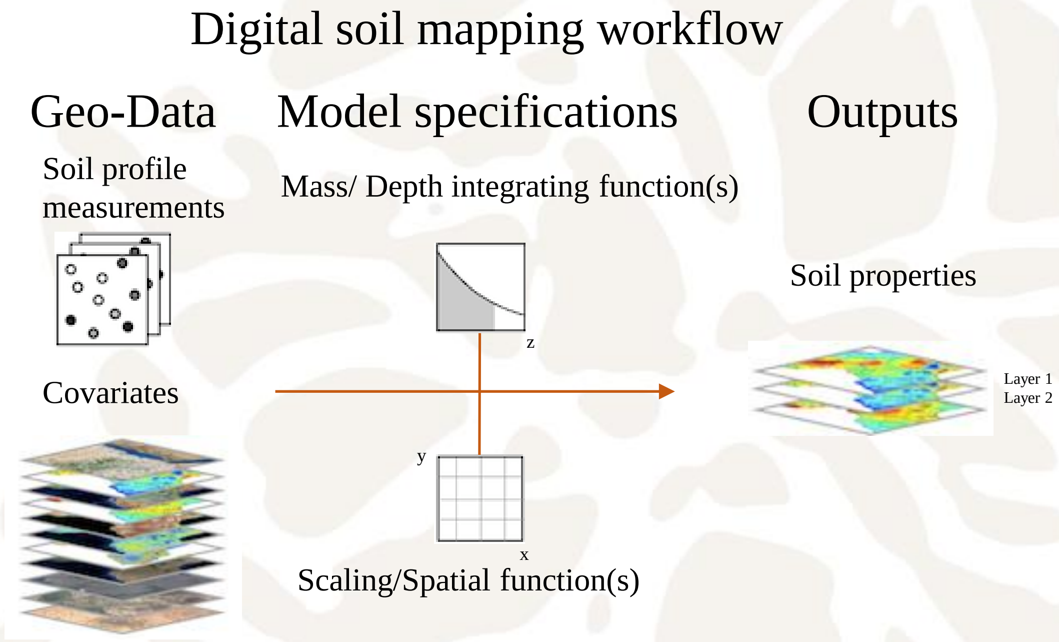
Climate change and beyond

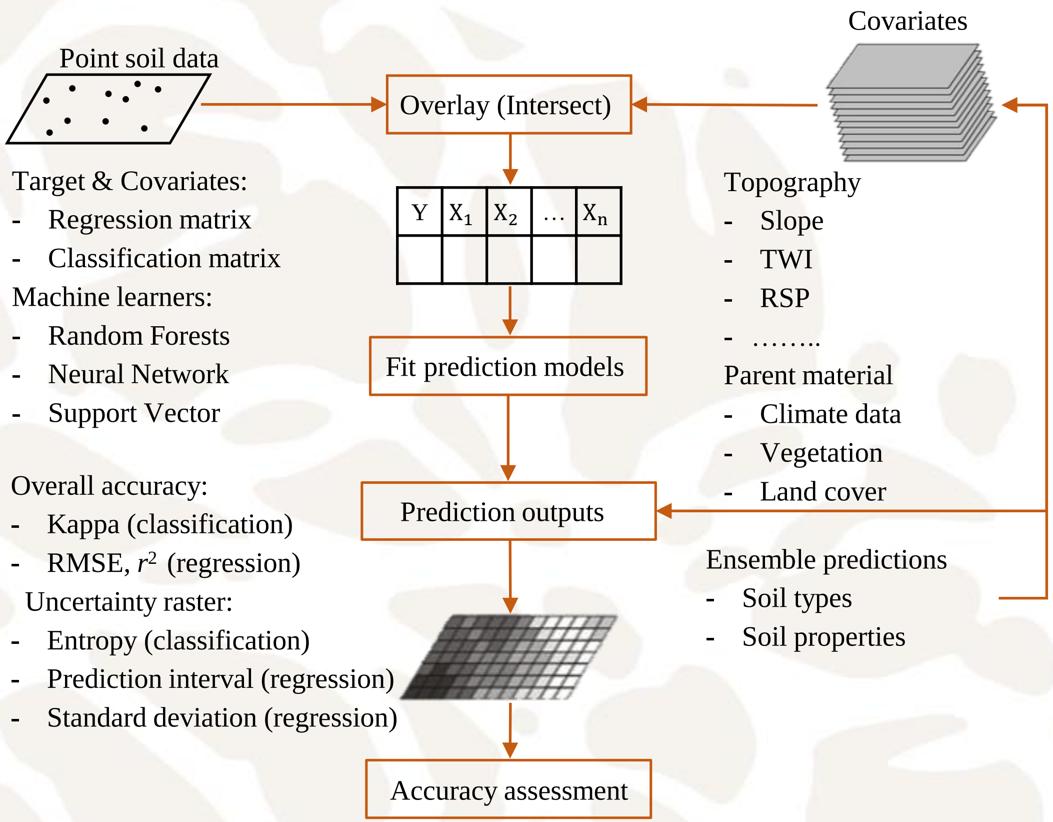
Table 1. Potential effects of increasing droughts and excessive moisture on trends of soil quality indicators.

Soil Health Indicator	Climate Linkage (Direct and Indirect)	Effects of Increased Droughts	Effects of Increased Excess Moisture	Comments Regarding Other Factors
Soil erosion by wind	Wind, temperature and precipitation, soil moisture, vegetation cover	Reduced soil moisture and vegetation cover which increase erosion risk	Increased precipitation intensity can destabilize soil particles	Decreasing snow cover increases exposure to erosion
Soil erosion by water	Precipitation intensity, vegetation cover	Water erosion risk decreases	Increased heavy rainfall increases potential for soil erosion	Heavy rainfall on frozen soil increases erosion risk
Soil organic carbon	Temperature, precipitation, vegetation cover	Reduced vegetation production reduces carbon	Run-off increases carbon losses	Temperature increases tend to increase carbon losses
Soil salinization	Aridity (temperature and precipitation balance), vegetation cover	Evaporation concentrates salts. Reduced vegetation cover can increase salinization	Elevated water tables can increase salinization	Increased variability with drought/wet shifts increases salinization risk
Contamination by trace elements	Precipitation intensity	Possible increased concentrations may occur	Increases	Climate effects estimations require further investigation

Heaton E., and Kulshreshth, S. 2017. Environmental Sustainability of Agriculture Stressed by Changing Extremes of Drought and Excess Moisture: A Conceptual. Sustainability 2017, 9, 970; doi:10.3390/su9060970

Cost-effective way of soil data renewal





Black soil distribution and report

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BLACK SOILS

1. **Country name**

   Canada

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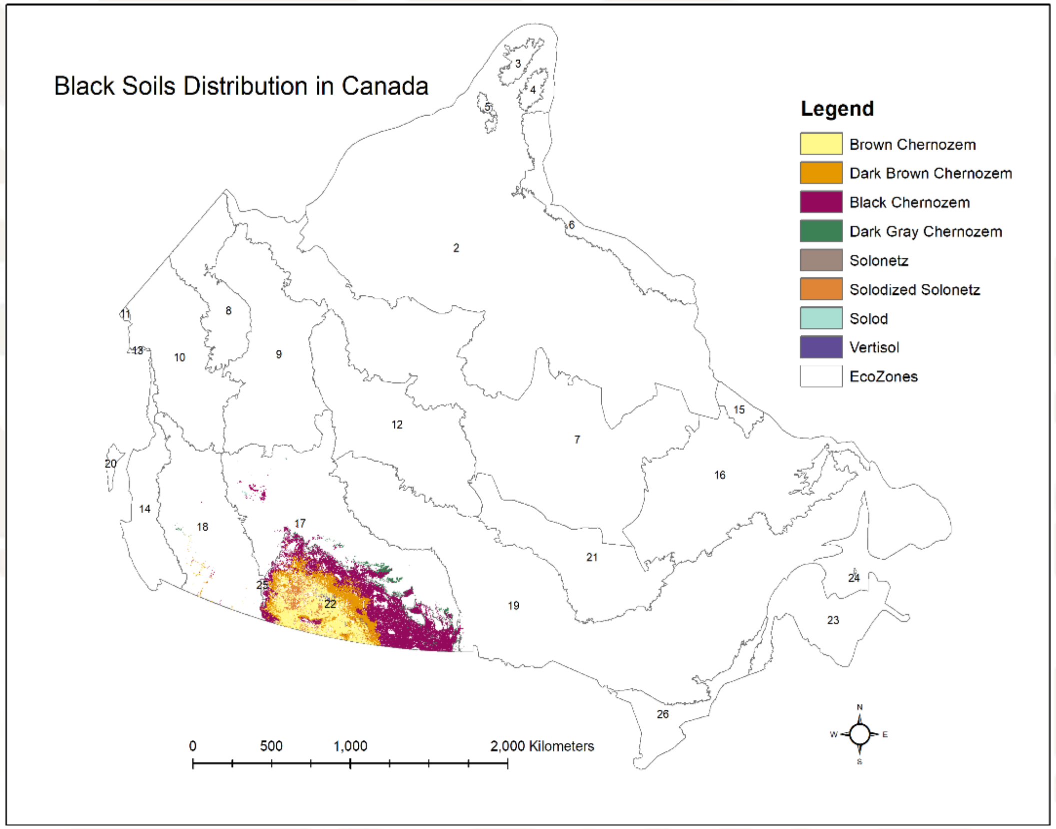
3. **Photos of the most representative soil profile of the Black Soils of the country**

   Black soils or Chernozemic (Mollisols) soils are found in sub-humid to semiarid regions in Canada. They are mainly located in the Prairies of Canada. Soils matching the definition of black soils from the International Network of Black Soils could include other soils than the ones from the Chernozem order. The selected two representative soil profiles here are from Black and Brown Chernozemic Great Group soils respectively, from the Canadian System of Soil Classification (Soil Classification Working Group, 1998).

   Figure 1. Typical soil profile of Black Chernozemic soils in Canada (CanSIS, https://sis.agr.gc.ca/cansis/taxa/soil/chernozemic/black_pr.jpg, accessed December 10, 2020)



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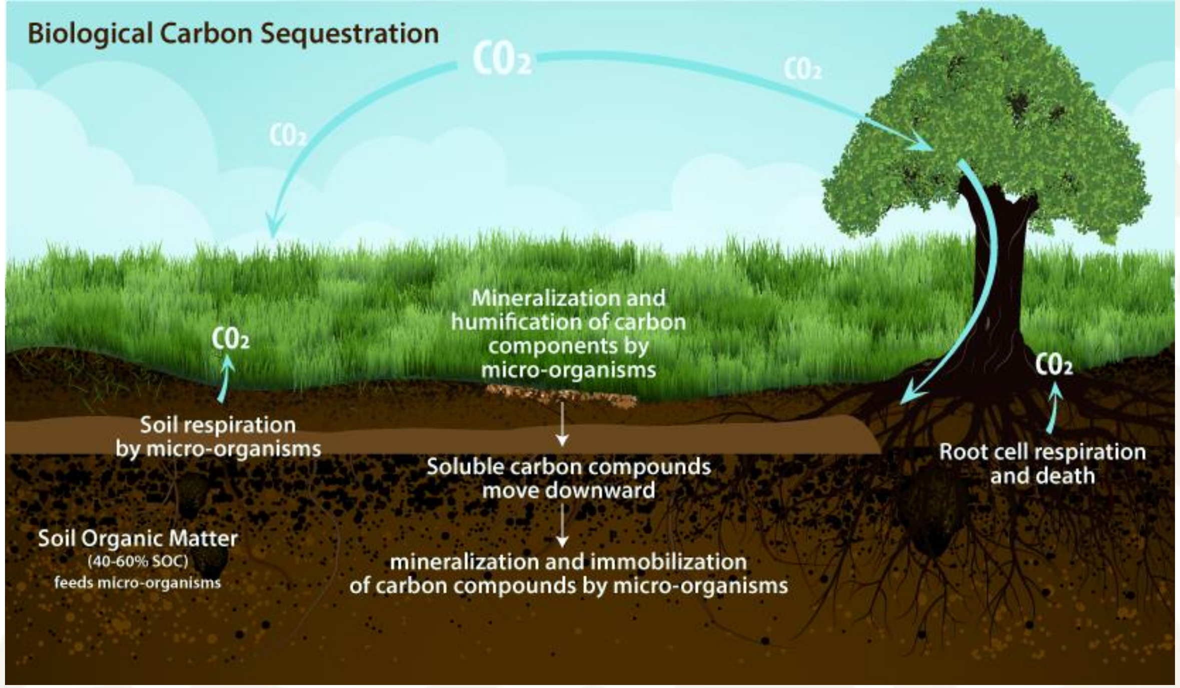
SOC and SOC sequestration



https://www.calrecycle.ca.gov/images/cr/organics-images/compostmulch/toolbox/biosequest.png

Total soil carbon (C): soil organic C (SOC) and soil inorganic C (SIC)

SOC: ratio of soil organic matter (SOM) and SOC is about 1.724

Soil C sequestration: to increasing SOC and SIC stocks in soil

National soil carbon sequestration potential

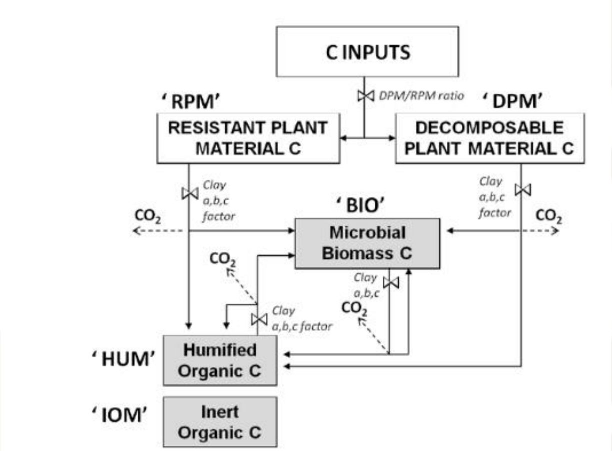
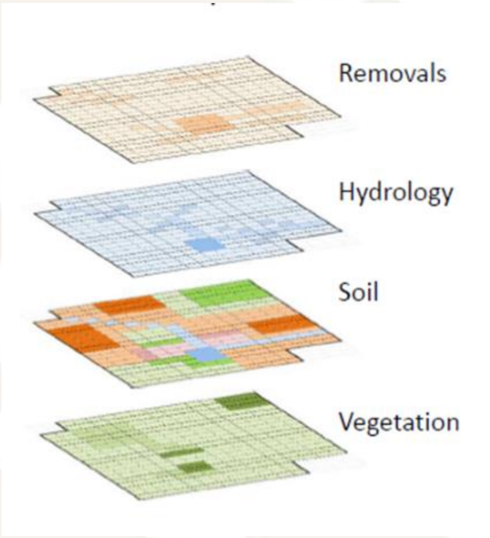
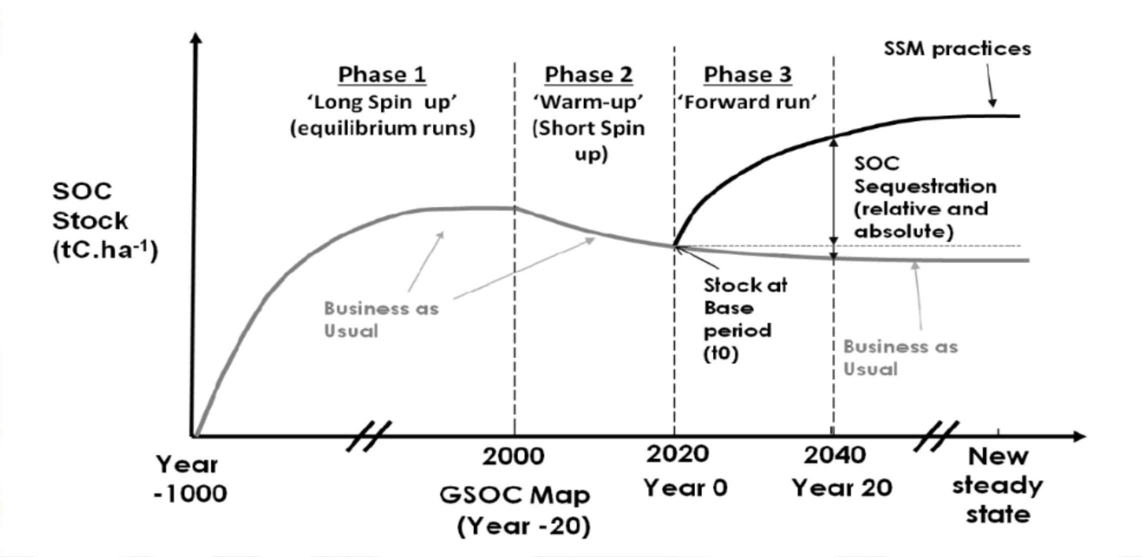
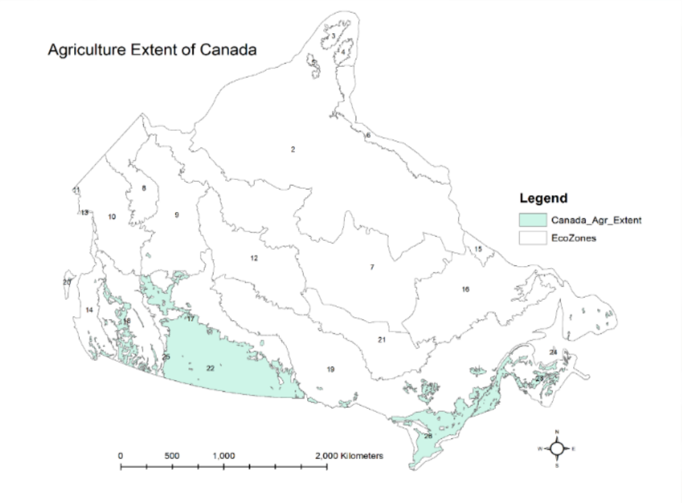


Figure 4 Structure, pools, and flows of carbon in the Roth-C model, including major factors controlling the fluxes (
= multiplier for effects of temperature, b = multiplier for effects of moisture, c = multiplier for effects of soil cove
DPM/RPM = Decomposable/resistant plant material ratio). *Source: redrawn from Coleman and Jenkinson (199*
and Falloon and Smith (2009).





Spatially explicit SOC sequestration assessment



Upper Medway Watershed, Ontario

T0=84, DiffBAU=0.82, DiffSSM2=2.59 (Mg/ha)

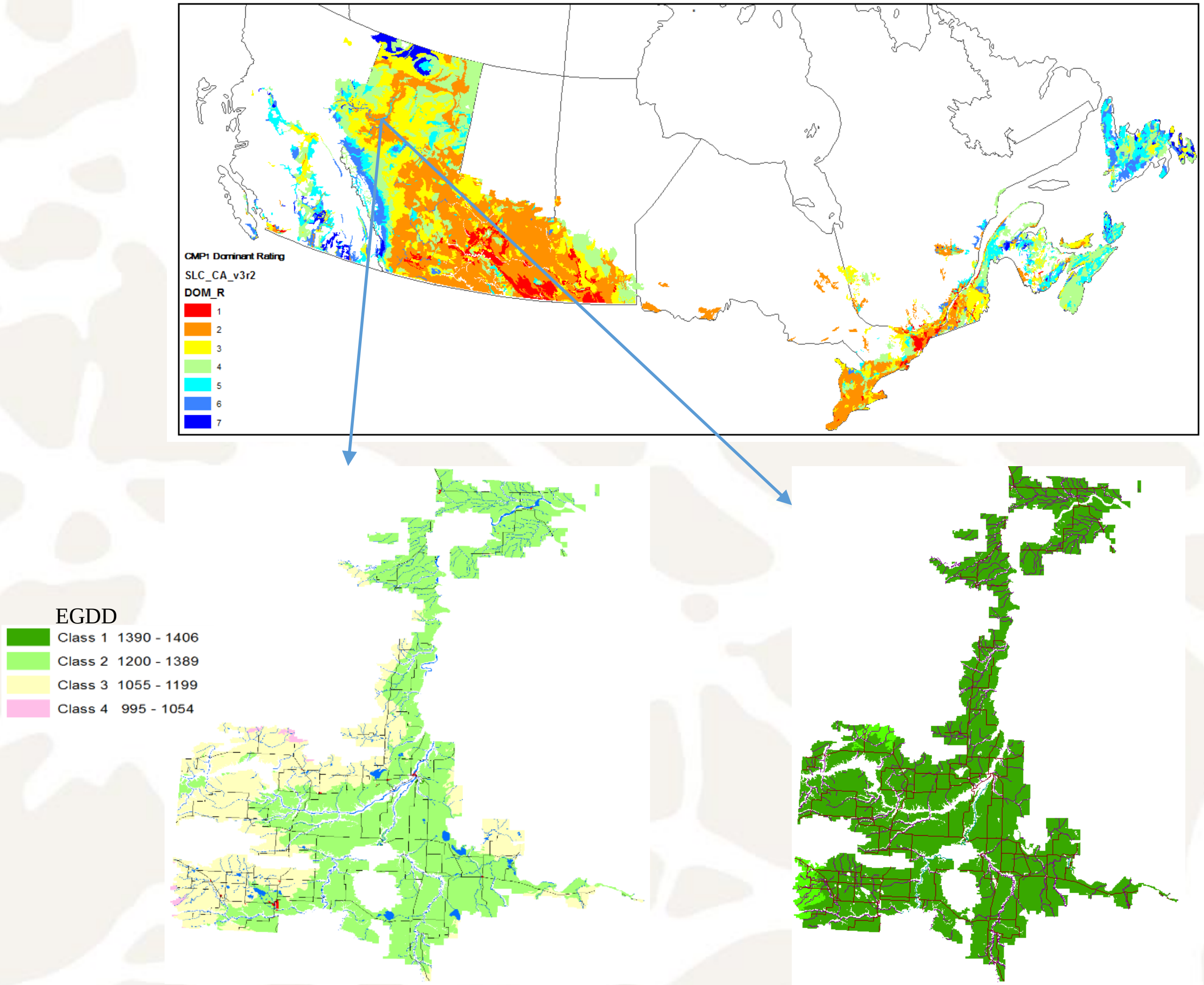
Average and total SOC stocks of agriculture land by 2040 in Canada

Scenarios	*Average SOC by 2040 (0- 30 cm Soil) Mg/ha*	*Total SOC by 2040 (0-30 cm Soil) t x 100 Mg/ha*	*Remarks*
Business as usual	100.37	40,567,404	Average SOC is 96Mg/ha T0: 97Mg/ha
Lower level sustainable management 5% more SOC input	101.07	40,839,678	Total SOC stock needs to multiple by 100 Mg/km^2
Medium level sustainable management 10% more SOC input	101.78	41,108,986	
High level sustainable Management 20% more SOC input	103.13	41,621,705	Area class maps are available as well

Climate change and crop suitability assessment

LSRS rating of Canola in Canada

Dorminent Rating for Component 1 (1981-2010)



Thank you!

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