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Current status of maritime soils: specific focus on PEI soils.

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2019 Island Agrology Workshop, August 18-20th

Canada

Outline

- SOM as an indicator of soil quality
- Factors affecting C storage
- Role of annual mineralization in affecting C storage
- Contribution of different types of residue to C storage
- 30 yr change of C storage western- versus eastern Canada
- Long-term trend of SOM in PEI

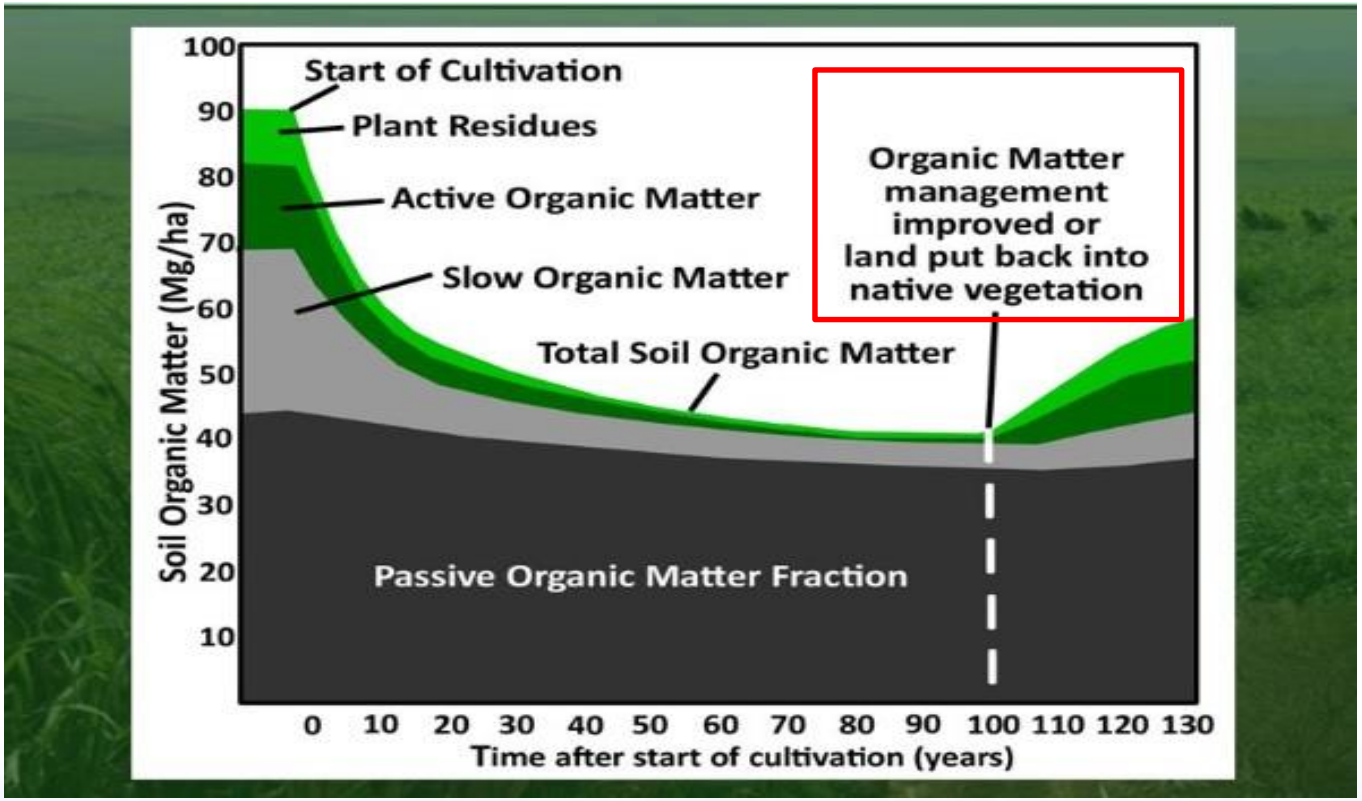
SOM, indicator of soil quality

- **Enhances soil resiliency against degradation**
- **Reduces soil compaction, enhances aggregation, water infiltration, and soil aeration**
- **Increases ability of a soil to supply nutrients**
- **Food source for the soil living organisms**
- **Mitigates climate change, stores CO_2 from the atmosphere**

Factors affecting C storage

- **C storage is affected by balance of:**
  - **Soil C inputs (plant and animal residues) and**
  - **Soil C losses (decomposition, erosion, uptake through plant and animal production)**
- **Soil type**
- **Soil management practices**
- **Climate**

SOM, mixture of organic compounds



After 40 yr of cultivation, the active SOM has lost 90% of its mass. Much of the loss comes at the expenses of active SOM (Brady and Weil, 2002).

The higher the active C (labile C)= the more biologically active is the soil (greater potential of nutrient turnover).

Annual mineralization rate of SOM (K_2)

Soil texture	Mineralization coefficient (% per year)
Sandy	2.5
Sandy loam	2.0
Sandy clay, loam, clayey sandy	1.2-1.5
Clayey	1

Adapted from Soltner, 1996

Yearly SOM decrease due to annual mineralization

Example of a sandy loam soil with:

3% SOM

Plow depth: 20 cm (8 inches)

Bulk density : 1.4 tonne/m^3

SOM reserve: 84 tonnes/ha

Annual losses due to mineralization (mineralization rate of 2%)= 1.7 tonnes/year/ha)

Proportion of crop residues and organic amendments to stable carbon (dry matter basis)

Crop residue	Coefficient of humication (K_1)	Organic amendments	Coefficient of humification (K_1)
Alfalfa (1st year)	0.20	Well decomposed manure	0.50
Prairie (establishment year)	0.15	Partially decomposed manure	0.40
Winter cereal		Manure with straw	0.25
Above ground	0.15	Dry straw	0.15
Below ground	0.15		
Grain corn		Sludge for waste treatment	0.20
Above ground	0.12		
Below ground	0.15		
Spring cereal			
Above ground	0.15	Adapted from Soltner, 1996	

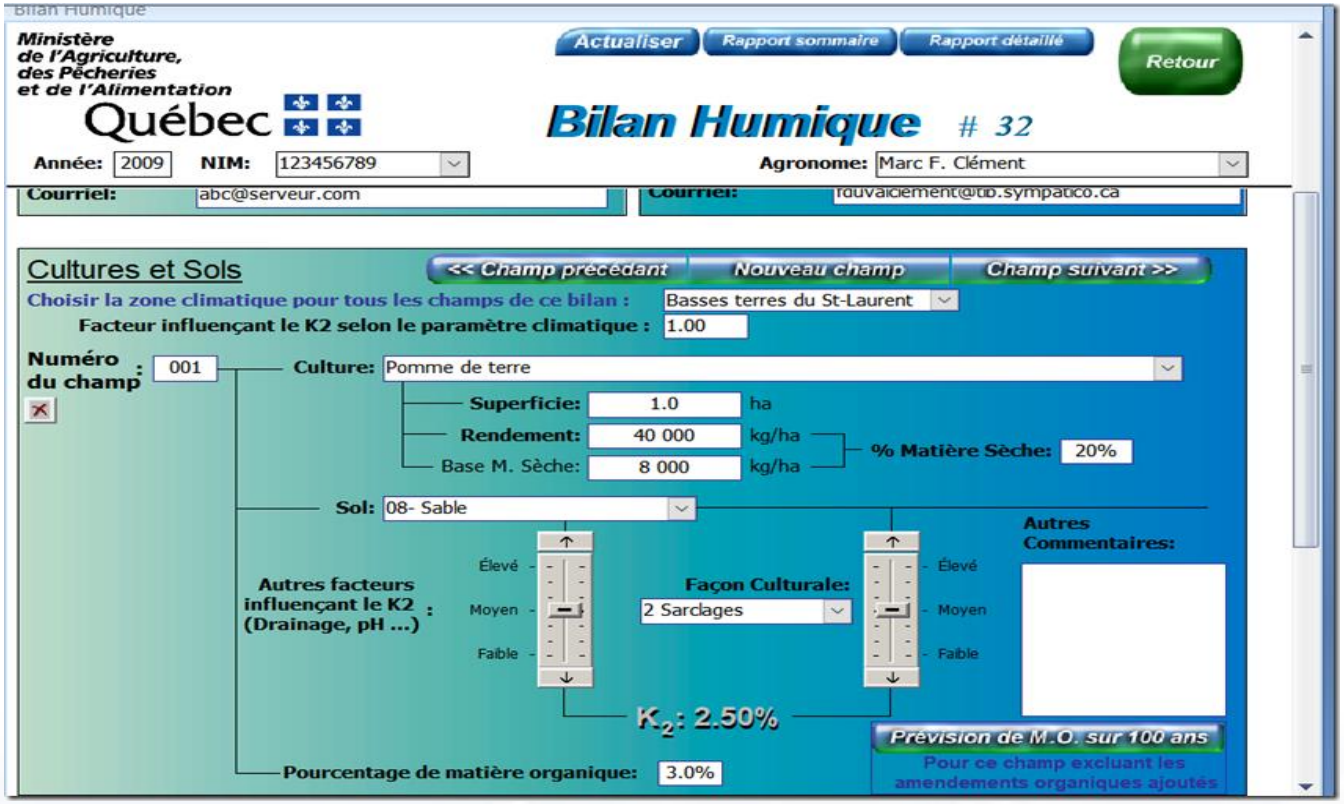
Estimate C storage trends based on:

Mineralization coefficient (K_1)

Humification coefficient (K_2)

Free software

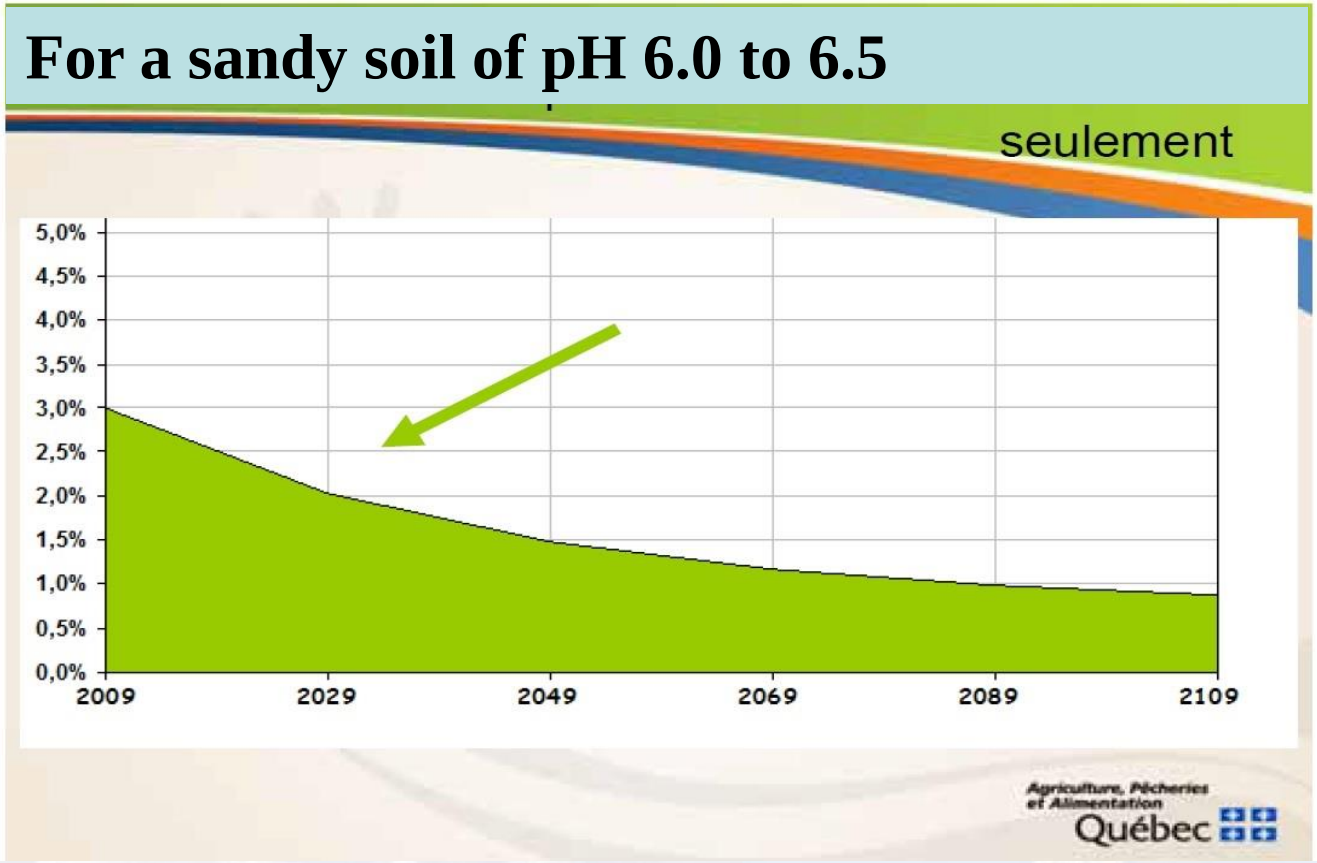
Humus balance simulation: free software



Annual mineralization rate= 2.5% on a sandy soil, with a rotation potato-oat (straw stays in field) with no organic amendments added.

http://www.mapaq.gouv.qc.ca/fr/Productions/Agroenvironnement/fertilisants/Pages/Bilanhumique.aspx

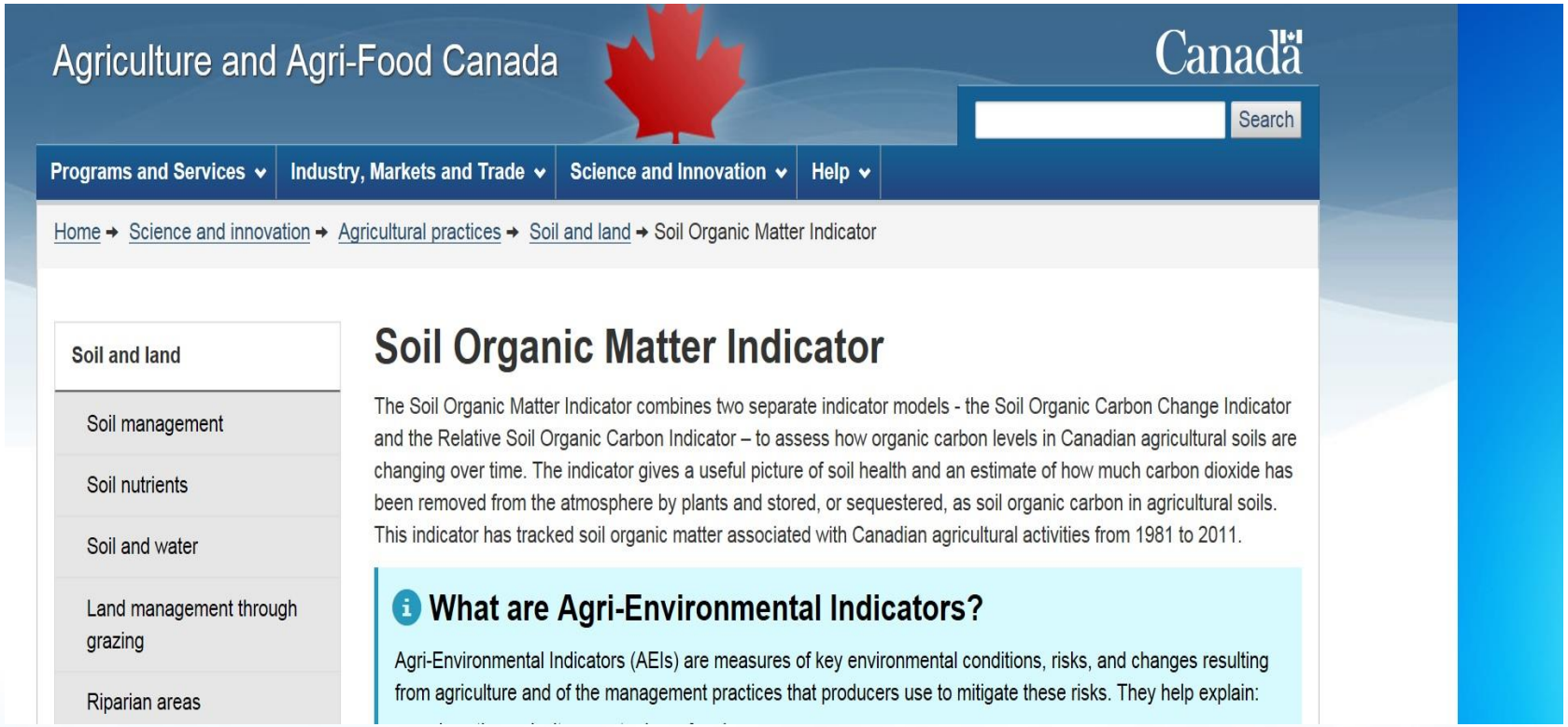
Humus balance simulation in a Quebec soil: rotation: potato-oat (straw stays)



SOM expected to go from 3 to 2% in 20 years.

https://www.craaq.qc.ca/UserFiles/file/Evenements/COLLSOL11/Clement_PPT.pdf

Soil organic matter indicator: eastern Canada versus western Canada

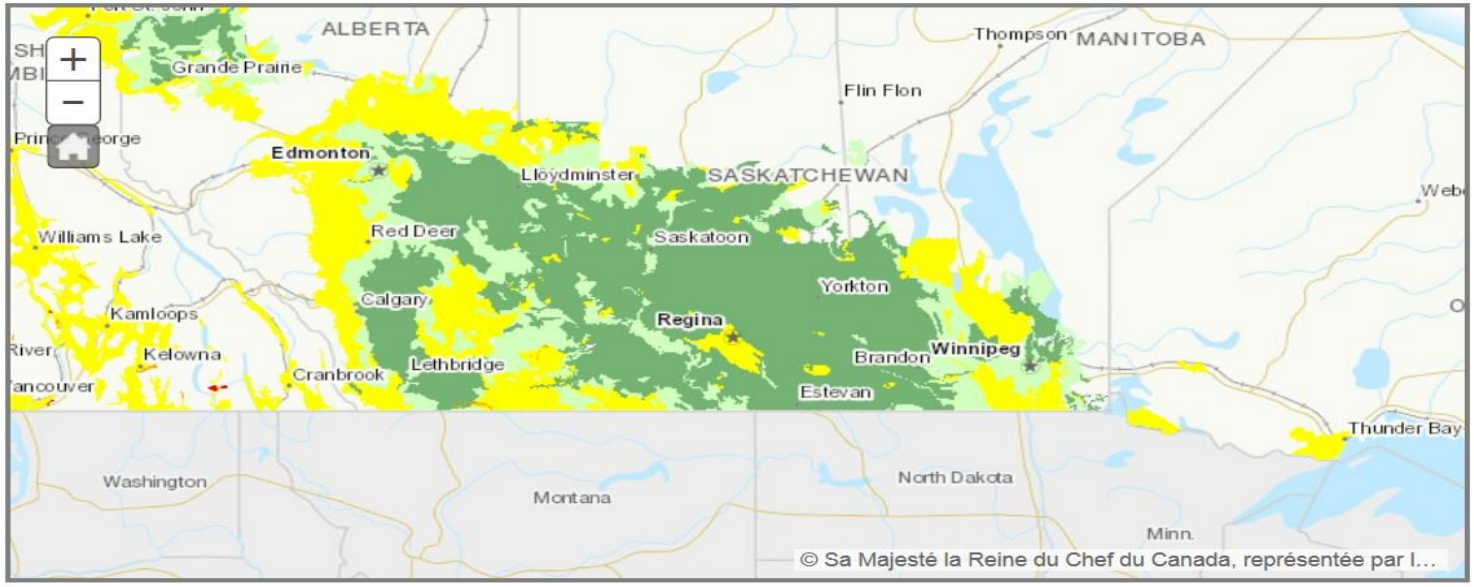


From 1981 to 2011

http://www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/soil-and-land/soil-organic-matter-indicator/?id=1462905651688

Cumulative soil organic carbon changes (kg/ha) in Western Canada

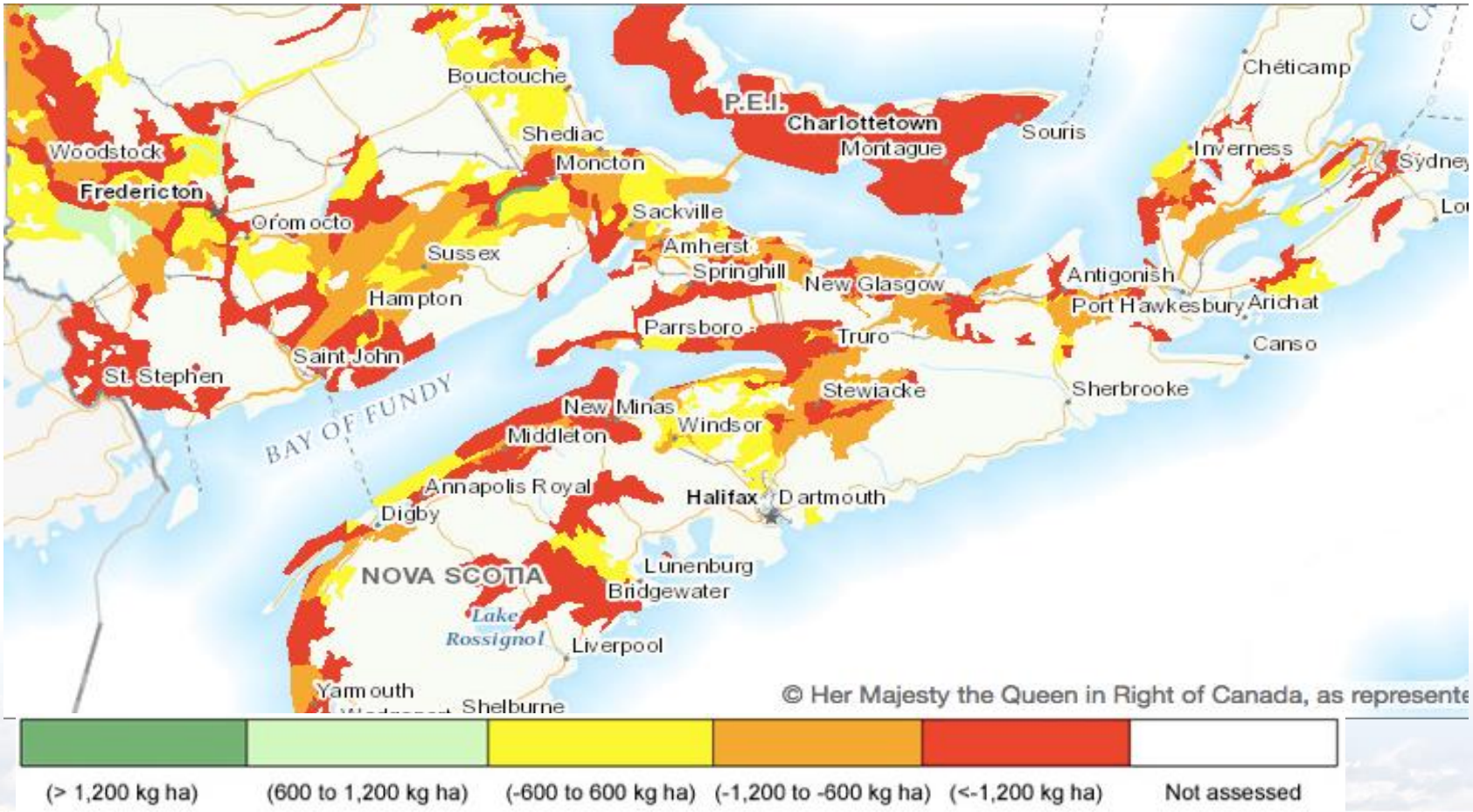
Figure 4: Cumulative Soil Organic Carbon change (in kilograms per hectare) from 1981 to 2011 due to changes in tillage and summerfallow



Legend:

http://www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/soil-and-land/soil-organic-matter-indicator/?id=1462905651688

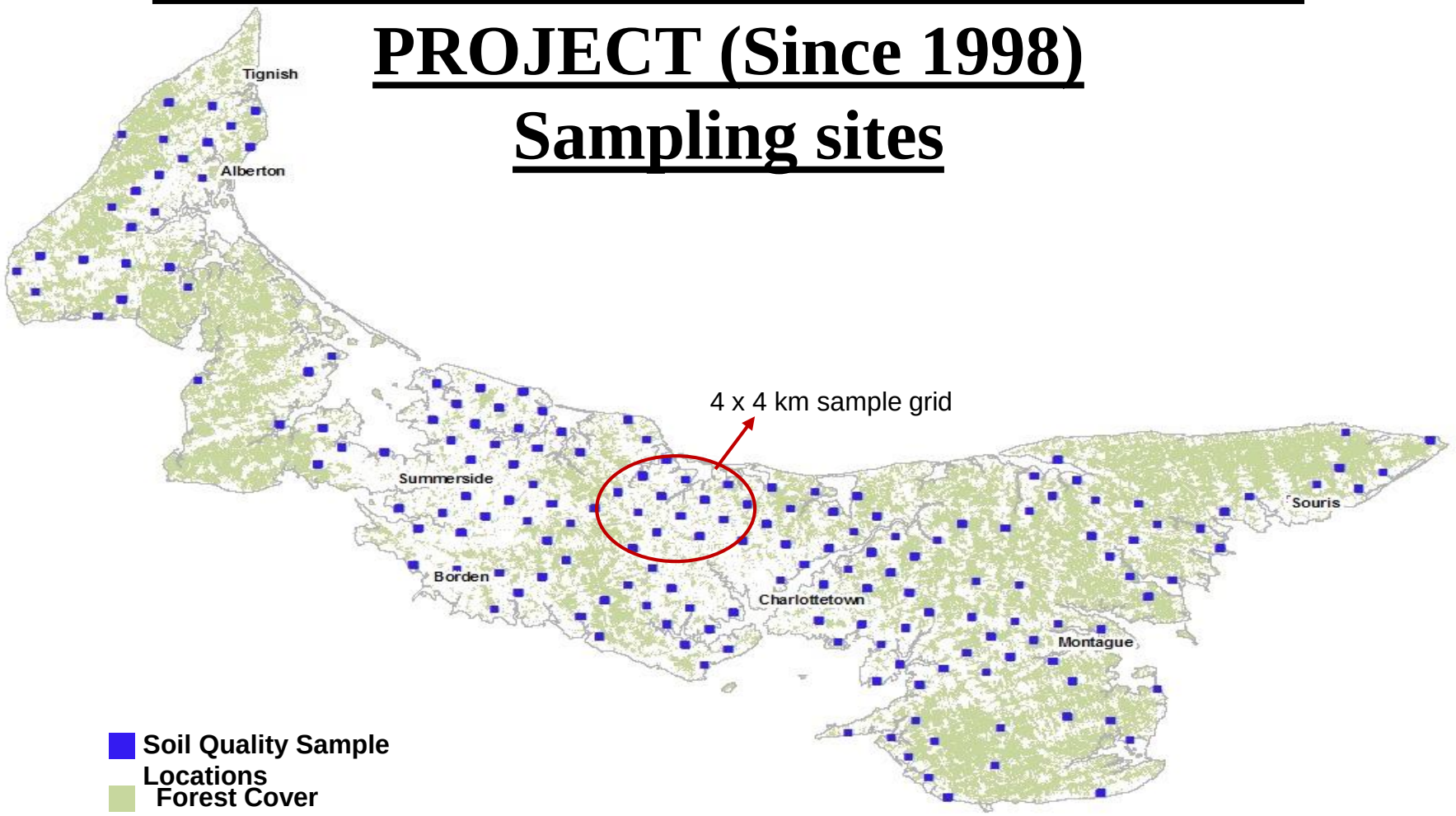
Cumulative soil organic carbon changes (kg/ha) in eastern Canada



http://www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/soil-and-land/soil-organic-matter-indicator/?id=1462905651688

PEI SOIL QUALITY MONITORING PROJECT (Since 1998)

Sampling sites



A composite soil sample is taken at each sampling point by mixing 5 subsamples. Return to the same site every three years.

PEI SOILS

- Podzolic soils rich in Al and Fe contents
-Sandy loam, well drained and fertiles
-Low in organic matter
-Prone to erosion

A dynamic agricultural industry changes

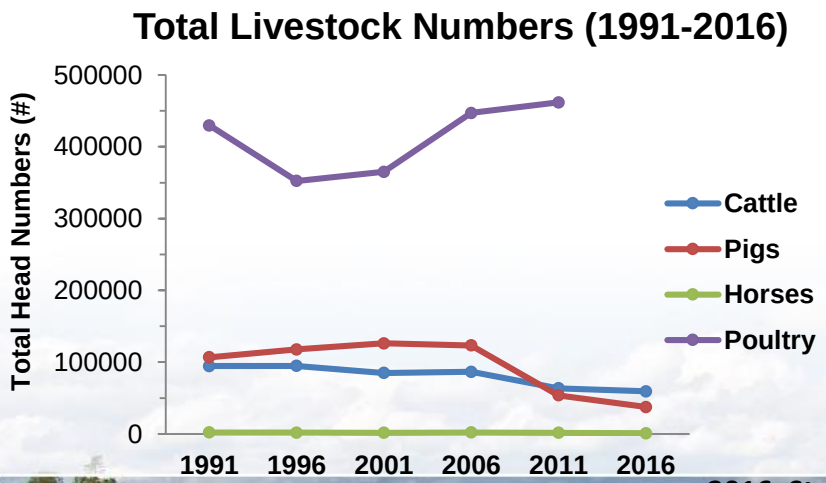
Increased

- New cleared land previously under forest (western PEI)
- Soybean acreage

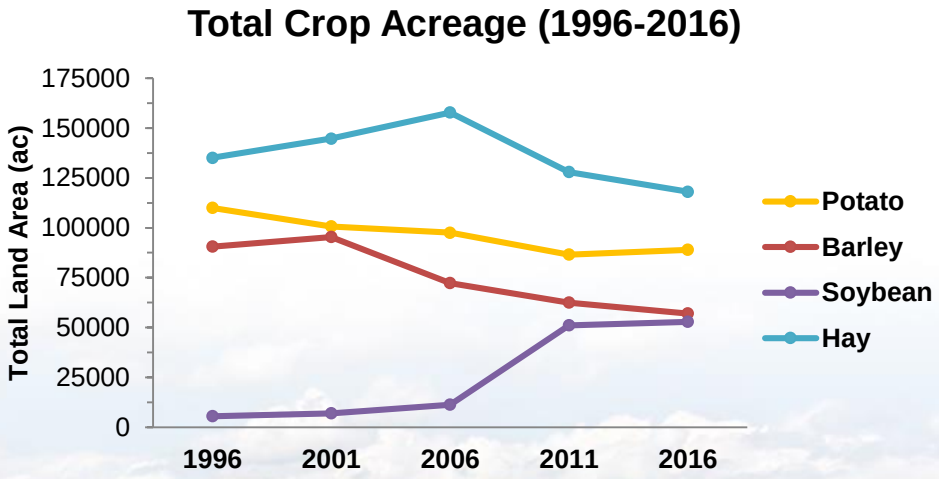
Decreased

- Potato acreage
- Number of livestock
- Manure input
- Forage/hay acreage

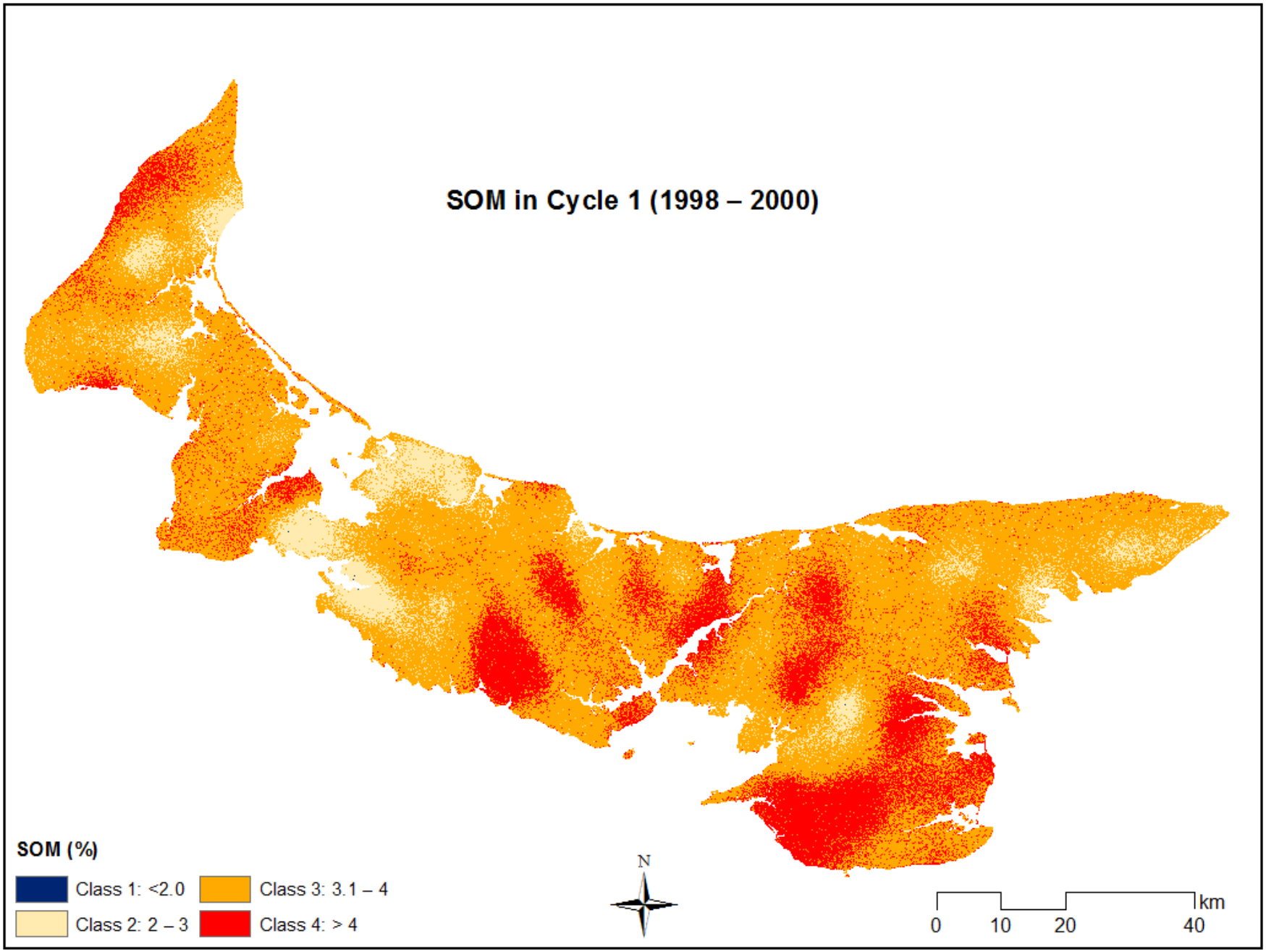
Crop rotation has changed due to wireworm pressure. Inclusion of new crops: mustard, buckwheat, soghum sudan grass

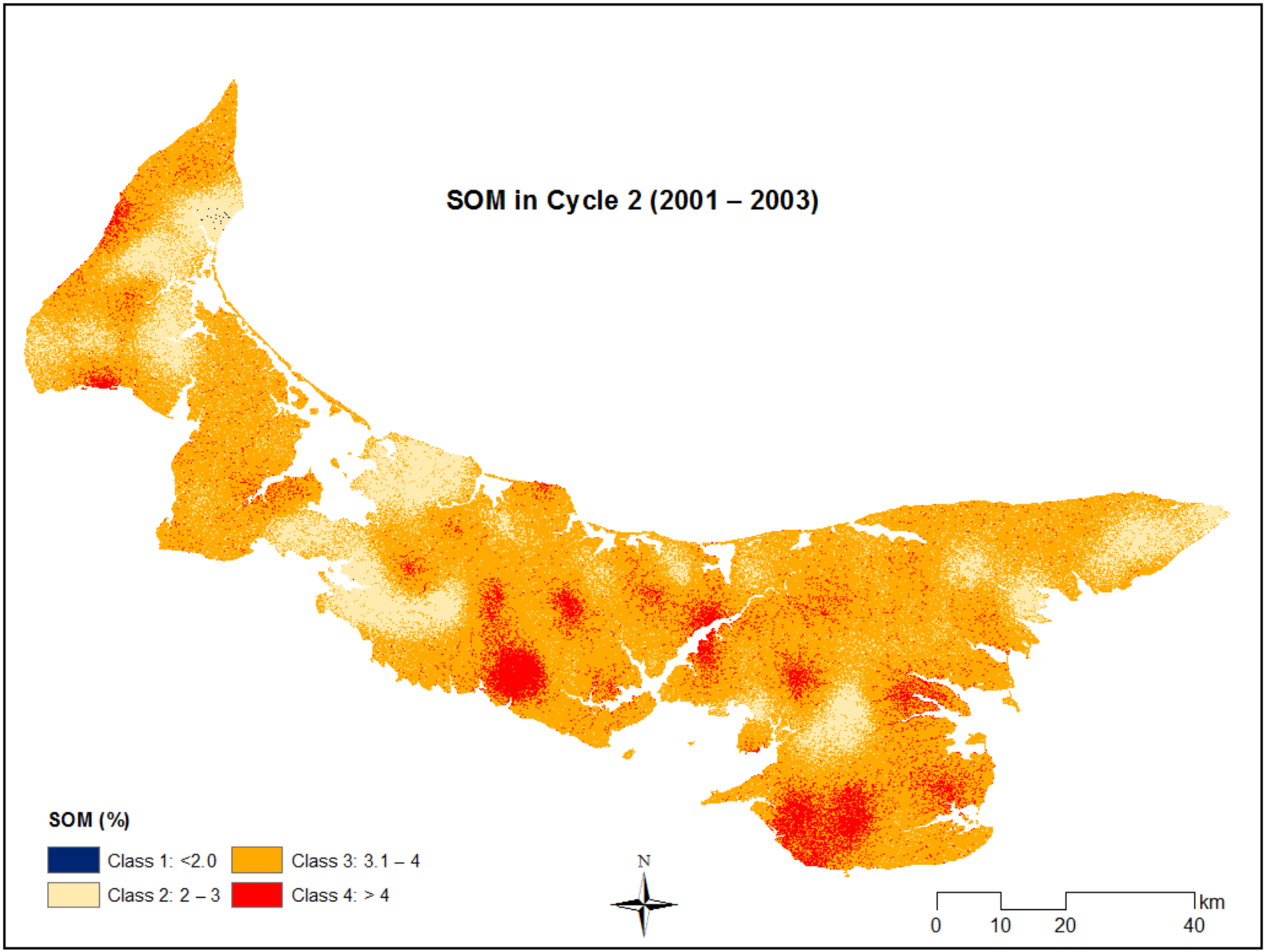


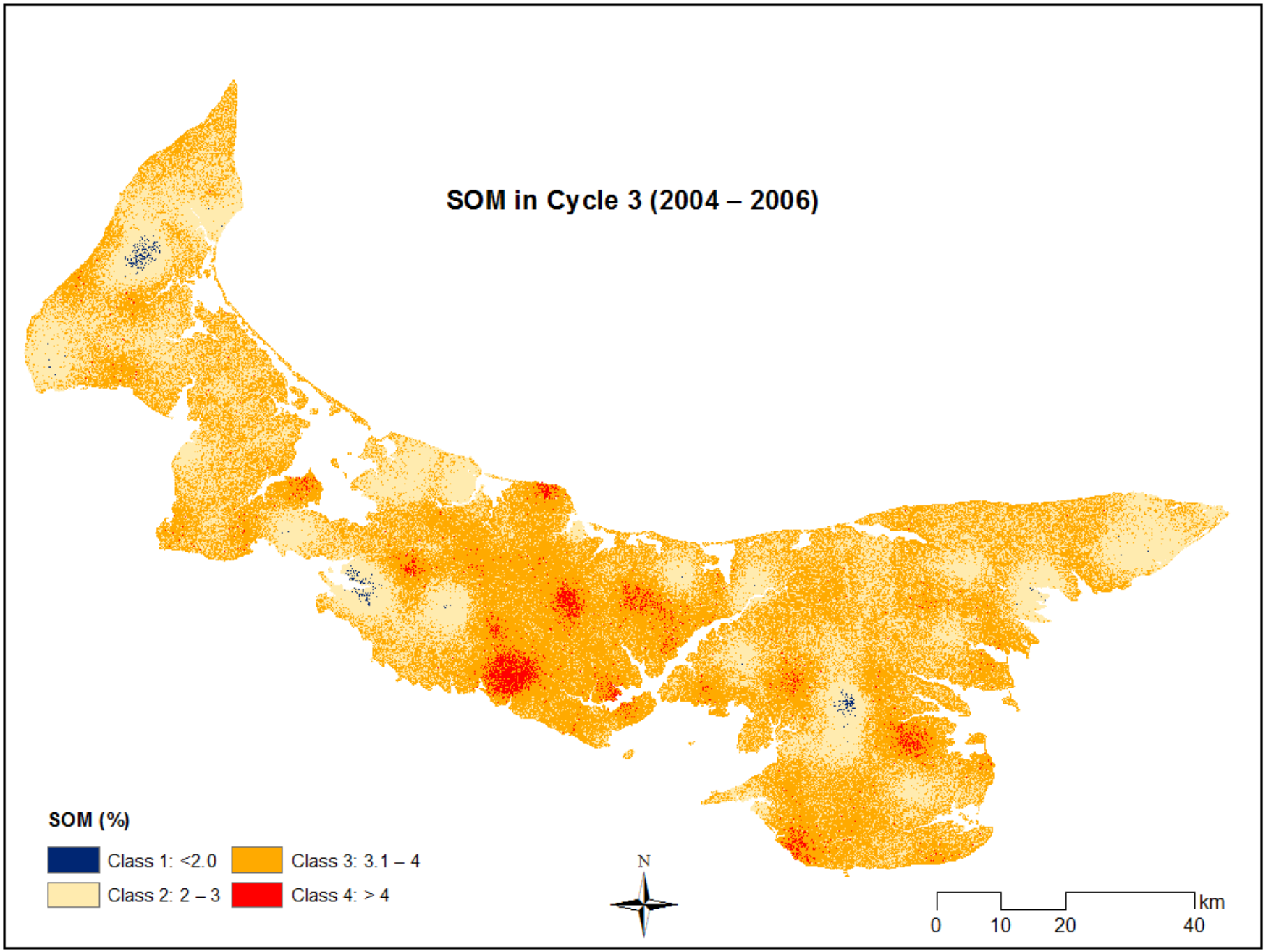
2016, Statistics Canada

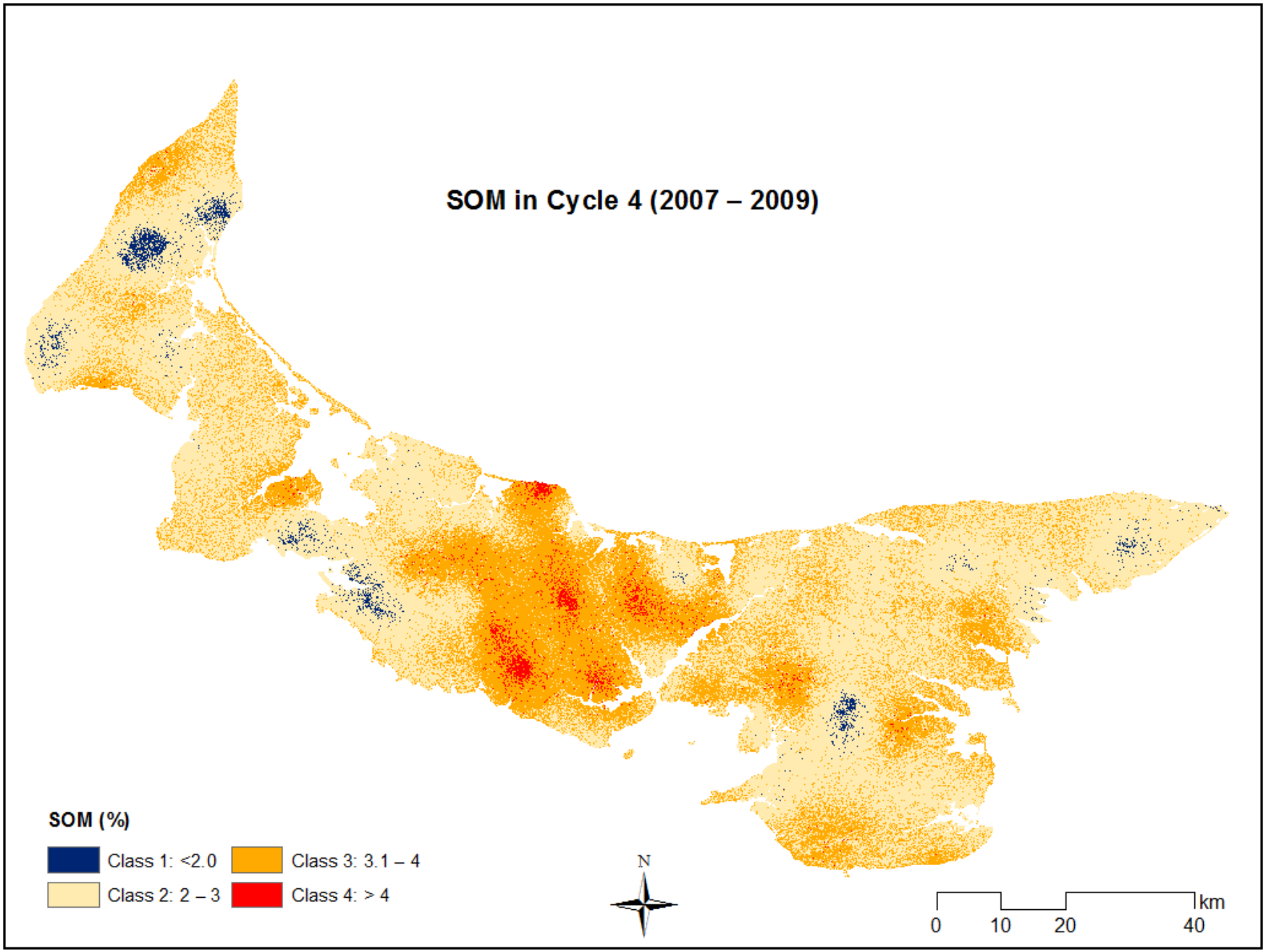


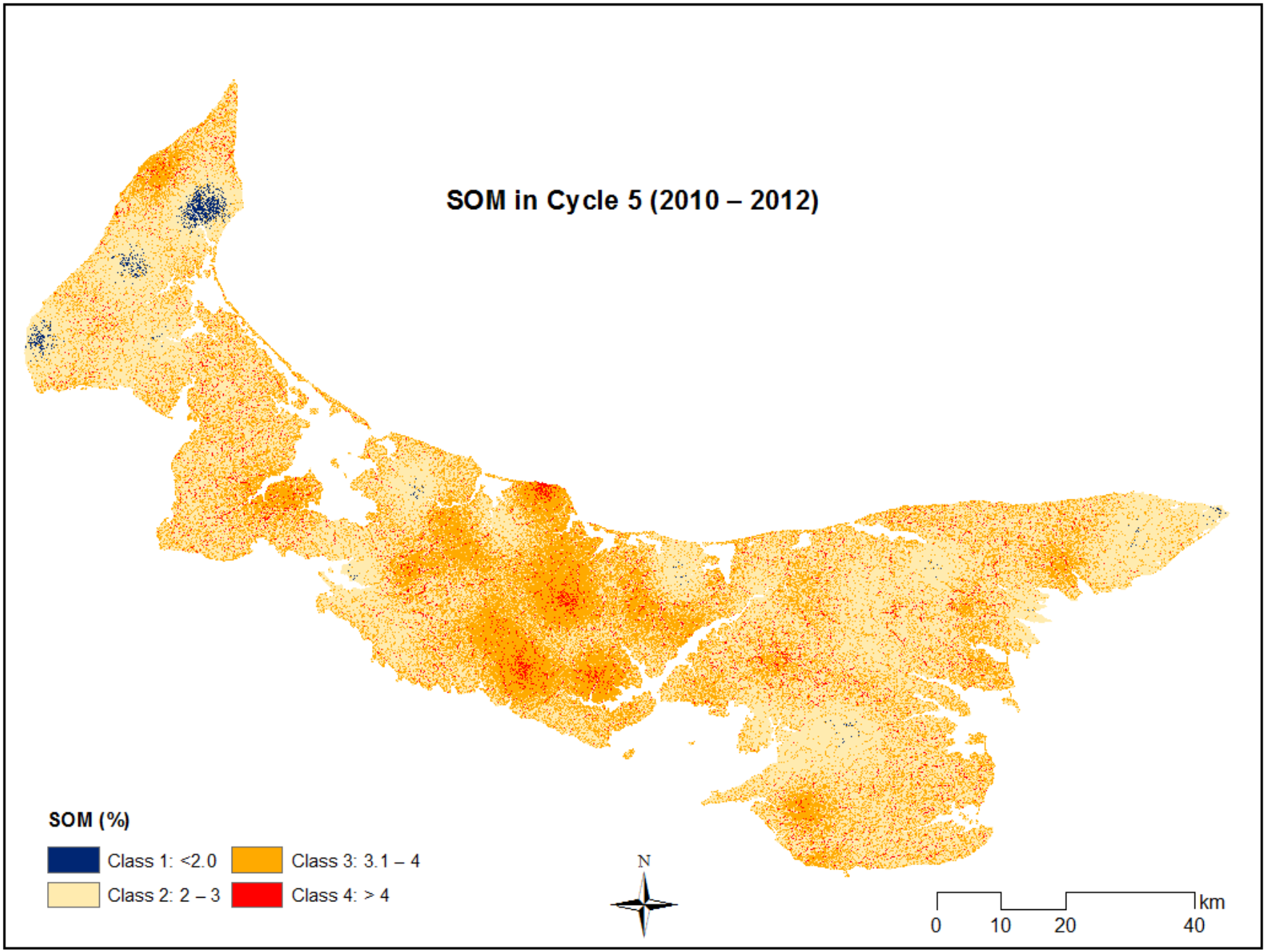
2016, Statistics Canada

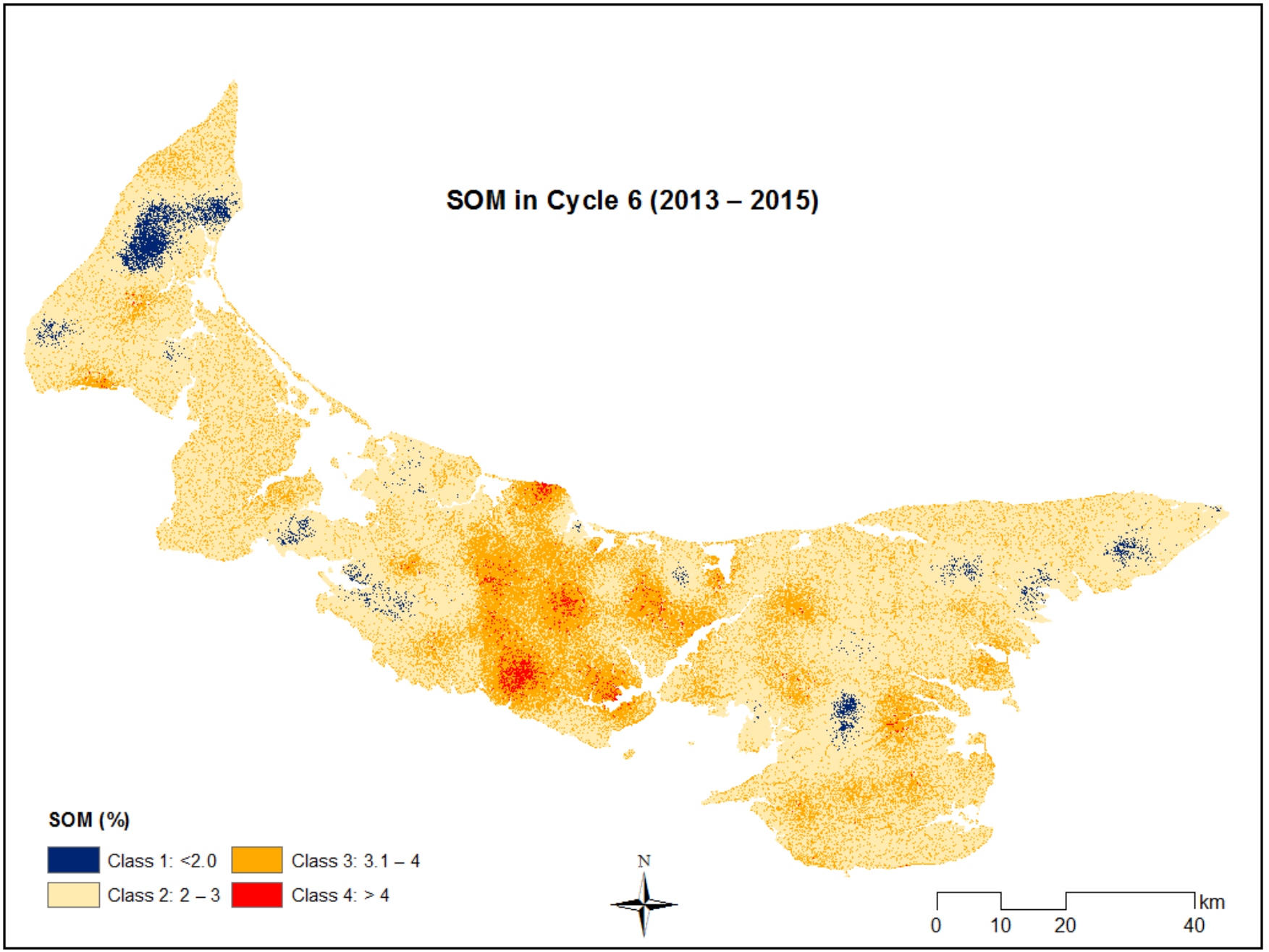

SOM in Cycle 1 (1998 – 2000)
SOM (%)
Class 1: <2.0
Class 2: 2 – 3
Class 3: 3.1 – 4
Class 4: > 4
N
0
10
20
40
km


SOM in Cycle 2 (2001 – 2003)
SOM (%)
Class 1: <2.0
Class 2: 2 – 3
Class 3: 3.1 – 4
Class 4: > 4
N
0
10
20
40
km

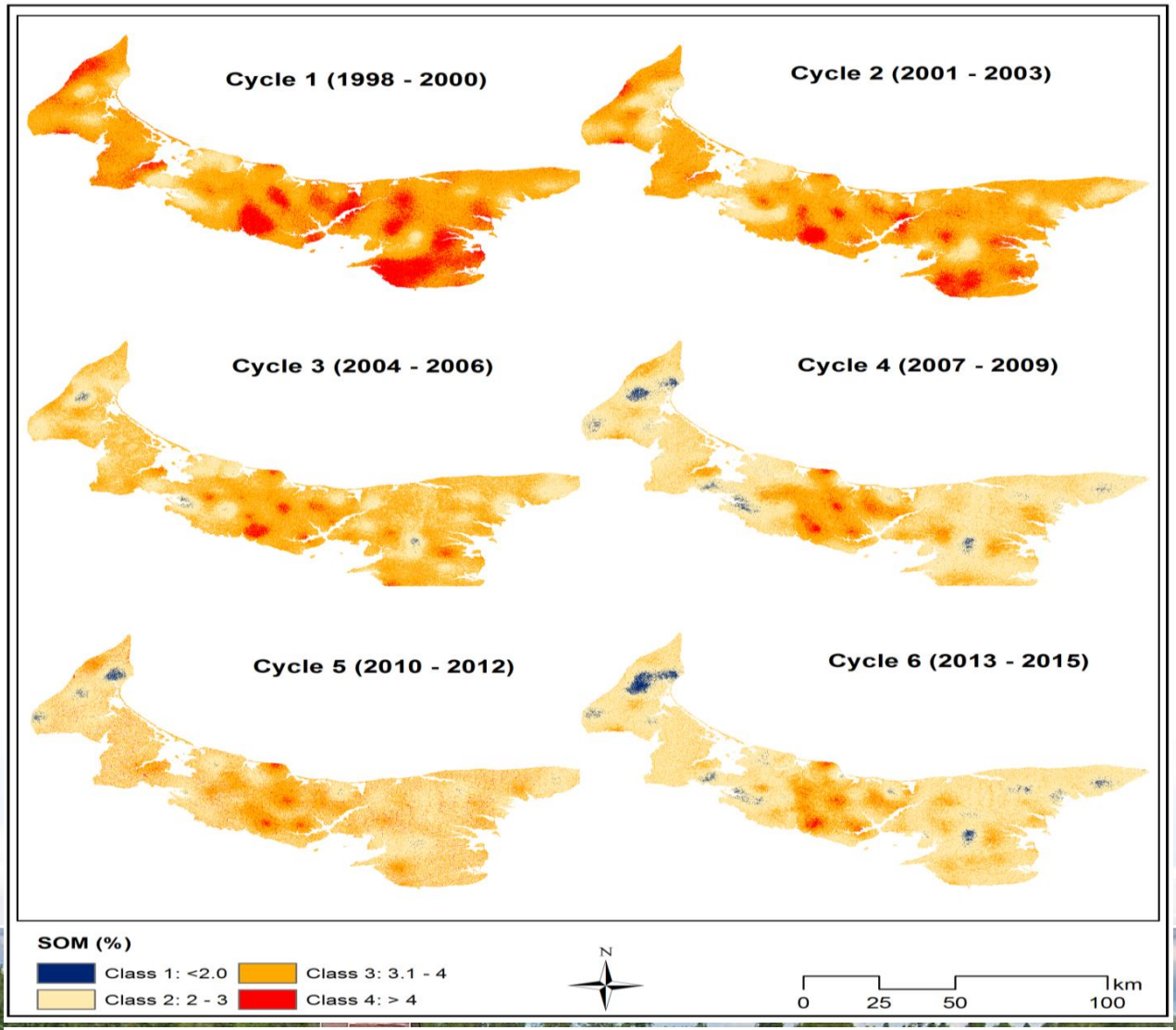

SOM in Cycle 3 (2004 – 2006)
SOM (%)
Class 1: <2.0
Class 2: 2 – 3
Class 3: 3.1 – 4
Class 4: > 4
N
0
10
20
40
km


SOM in Cycle 4 (2007 – 2009)
SOM (%)
Class 1: <2.0
Class 2: 2 – 3
Class 3: 3.1 – 4
Class 4: > 4
N
0
10
20
40
km


SOM in Cycle 5 (2010 – 2012)
SOM (%)
Class 1: <2.0
Class 2: 2 – 3
Class 3: 3.1 – 4
Class 4: > 4
N
0
10
20
40
km


SOM in Cycle 6 (2013 – 2015)
SOM (%)
Class 1: <2.0
Class 2: 2 – 3
Class 3: 3.1 – 4
Class 4: > 4
N
0
10
20
40
km

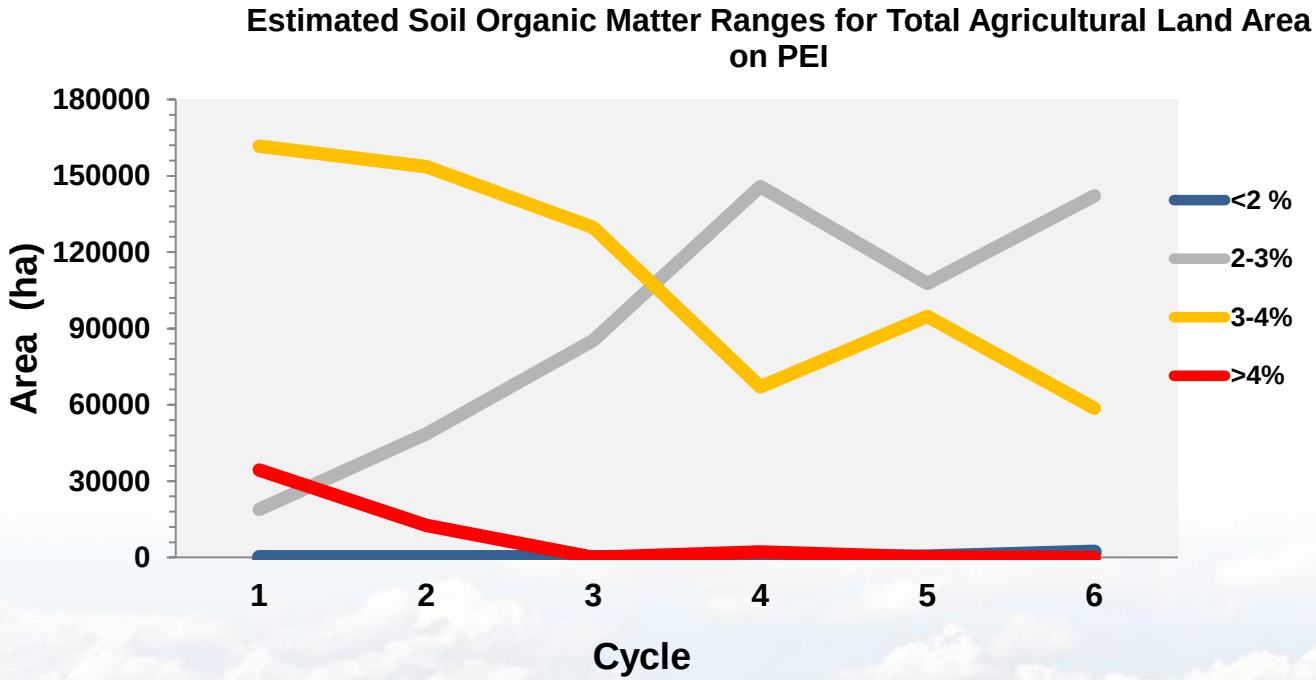
SOM trend over 18 years



Nyiraneza et al. 2018

Results

- Land acreage with SOM ranging from 2-3% has been increasing, and in the same time, areas with SOM between 3-4 and above 4% have been declining



2017, PEIDAF. "Soil OM Status on PEI" Factsheet.

Causes that can explain the trends

- **Intensive soil cultivation**(tillage intensity and frequency)
- **Changes in “traditional” crop rotations**
- **Reduced organic inputs (i.e manure)**
- **Nature of PEI soils**
- **PEI Climate**

Agricultural practices to maintain/enhance SOM

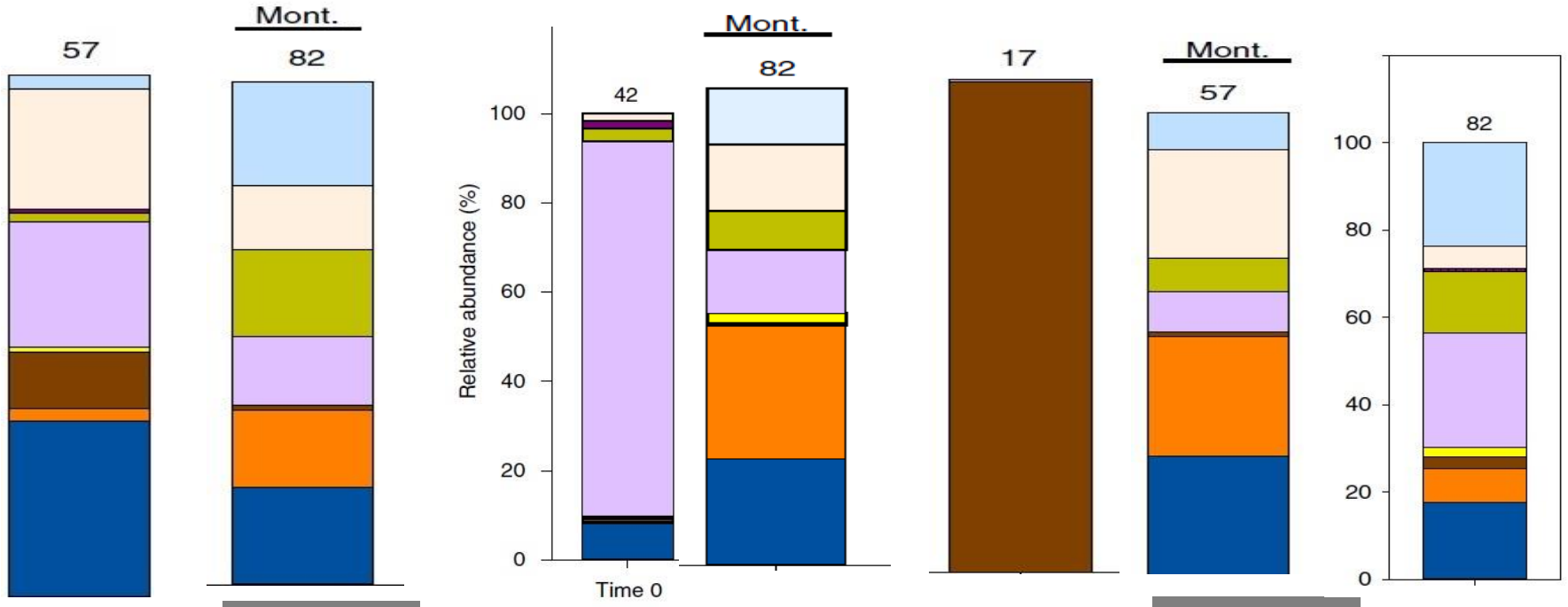
- ❖ **Enhances C inputs or reduce C losses:**
- ➢ **Enhance ground cover, minimize the time the soil is left bare**
- ➢ **Return crop residues to the soil**
- ➢ **Incorporate manure and compost if possible**
- ➢ **Implement reduced tillage and soil conservation practices**
- ➢ **Let the soil rest with perennial forages**

Building the SOM by feeding the soil microbes

Does the C input quality matter?

Does the C input quality matter?

Different C substrates+sterile clay minerals+multinutrient solution+ soil inoculum from soil slury. Incubation for 18 months.



Kallenbach et al. 2016

Summary from Kallenbach et al. study

- **« Stable SOM originates from microbes per se rather than the substrate they utilize ».**
- **Accumulated SOM was mainly composed of microbial products (proteins, non proteinaceous N compounds and lipids).**
- **After the incubation, > 75% of total substrate C- lost via respiration.**
- **Most of C was accumulated in the clay mineral having higher CEC that received slow decaying product (syringol).**

Kallenbach et al. 2016

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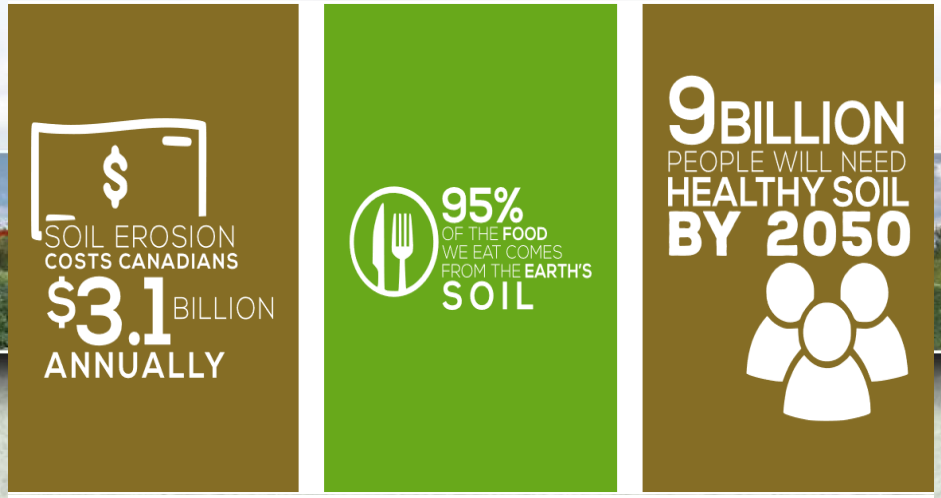

Soil Conservation Council of Canada
https://soilcc.ca/

Thank you for listening
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