Environment and Climate Change Canada
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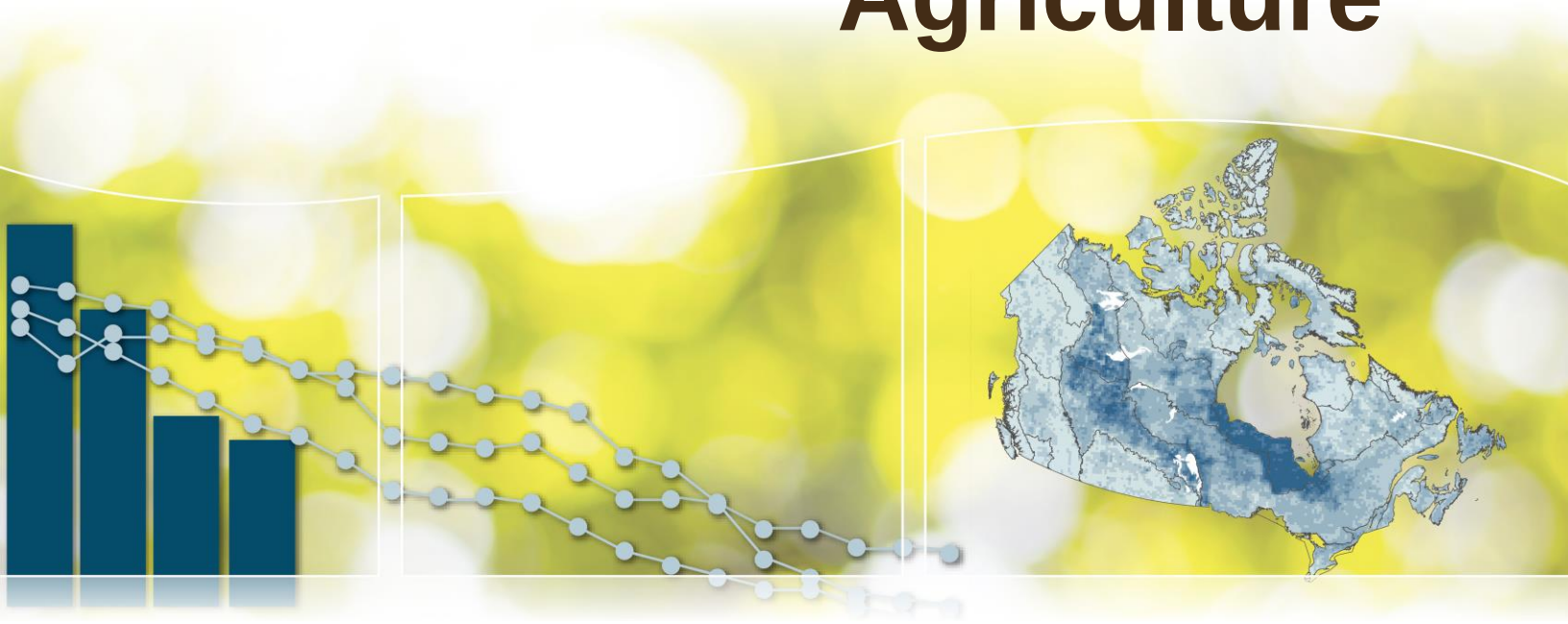
Canadian Environmental Sustainability Indicators

Risk to Soil and Water Quality from Agriculture



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Risk to Soil and Water Quality from Agriculture

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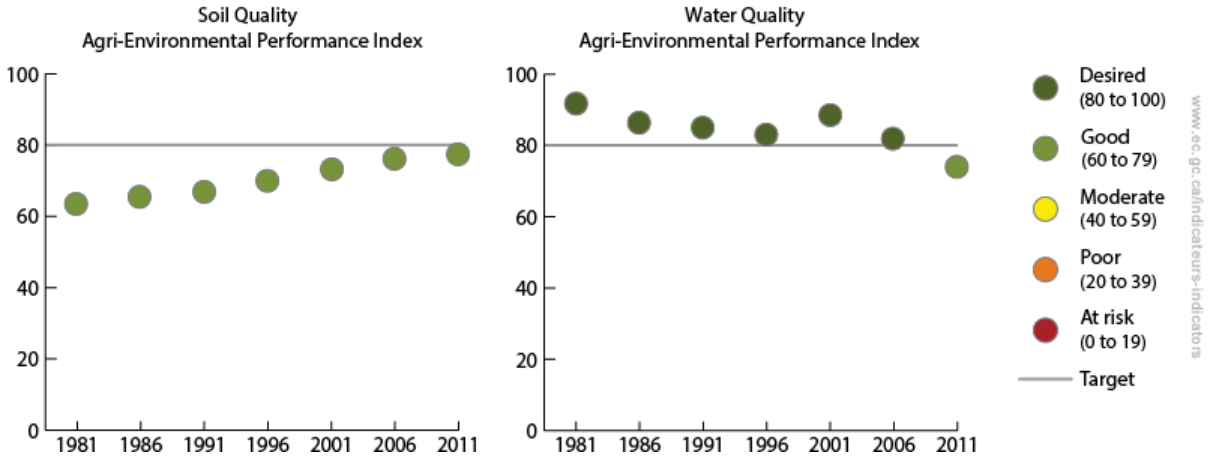
Part 1. Risk to Soil and Water Quality from Agriculture Indicator

Between 1981 and 2011, changes in farm management have helped improve agriculture's soil quality performance. The Soil Quality Agri-Environmental Performance Index results for Canada's farming regions are good and getting better.

While still rated as good, the Water Quality Agri-Environmental Performance Index has fallen below the desired level.

Figure 1. Agri-environmental performance indices for soil and water quality in Canada, 1981 to 2011



Data for Figure 1

Note: The graph's solid horizontal line corresponds to the lowest index value for the desired category. Agriculture and Agri-Food Canada has set a goal for the soil and water quality indices to achieve this level by 2030.
Source: Agriculture and Agri-Food Canada (2016) Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #4.

Since the end of World War II, market demand and new technologies have changed Canadian farming. Farms are now fewer and larger, with more cropland and livestock. Coupled with these changes is an increased awareness among producers and the public of the pressures agricultural production places on the environment. Protecting soil quality ensures a farm continues to produce abundant and healthy crops. A well-managed farm ensures harmful chemicals do not enter surface and ground water.

The Soil Quality Agri-Environmental Performance Index combines information about the risk of soil loss, contamination by trace elements, the buildup of salt and the reduction of organic matter in the soil. The index's improvement has largely occurred through the adoption of reduced-till or no-till farming practices, and a decline in summer fallowing particularly in the western provinces. In eastern Canada, higher rainfall supports more intensive crop production. When coupled with a higher, but declining, reliance on conventional tillage practices, soils in this region may be more affected by agriculture.

The Water Quality Agri-Environmental Performance Index combines information about potential water contamination by nitrogen, phosphorus, bacteria and agricultural pesticides. Some of the index's national variation can be attributed to weather conditions during the year data were collected. As well, greater application of fertilizers and manures on farms in recent decades has increased the opportunities for agricultural nitrogen and phosphorus, as well as bacteria, to reach water bodies. Since 2006, declines in livestock populations have led

to a decrease in perennial crop area and an increase in annual crop area. This change has resulted in an increased use of herbicides, pesticides and phosphorus fertilizer, increasing the risk of water contamination in some areas.

The index results that show producers are responding to environmental concerns and that progress has been made towards environmental sustainability. Further expansion and intensification of cropping and livestock production due to an increasing demand for food and fibre, or changing business conditions, could increase the environmental pressure from farming unless appropriate actions are taken to mitigate them.

This indicator is used to measure progress towards Target 3.10: Agri-Environmental Performance Metrics – Achieve a value between 81–100 on each of the Water Quality and Soil Quality Agri-Environmental Performance Metrics by 31 March, 2030 of the Federal Sustainable Development Strategy 2013–2016.

Part 2. Data Sources and Methods for the Risk to Soil and Water Quality from Agriculture Indicator

Introduction

The Risk to Soil and Water Quality from Agriculture indicator is part of the Canadian Environmental Sustainability Indicators (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues. This indicator is also used to measure progress towards the goals and targets of the Federal Sustainable Development Strategy 2013–2016.

Description and rationale of the Risk to Soil and Water Quality from Agriculture indicator

Description

The Risk to Soil and Water Quality from Agriculture indicator is comprised of Agriculture and Agri-Food Canada's (AAFC's) Soil and Water Quality Agri-Environmental Performance Indices which aggregate multiple indicators related to soil and water quality. They are derived from models and formulae that integrate data for soil, climate and landscape with data about crops, land use and land management.

Calculated for agricultural land in Canada, the indicators use a five-class rating system, which ranges from very low to very high risk. The soil organic carbon change indicator is classified based on magnitude and direction of change in organic soil carbon content, with large increases being preferred over large decreases. A performance index is calculated for each reporting year, based on a weighted share of land in each indicator class. Multi-indicator aggregations result in unit-less agri-environmental performance indices ranging from at risk performance (index value 0–19) to desired performance (index values of 80 or greater). The classification system and index scale are detailed in AAFC's Agri-Environmental Indicator Report Series – Report #4.

Rationale

The AAFC agri-environmental indicators, from which the Risk to Soil and Water Quality from Agriculture indicator is drawn, are designed to be a report card of agri-environmental performance for producers, consumers and the international community. They can be used to highlight areas where further efforts are required. They also provide valuable information that decision makers can draw upon when developing and evaluating agricultural policy. AAFC has set a goal to reduce risks to soil and water quality from farming to achieve the desired performance category in these two indices by 2030.

Recent changes to the indicator

Data from 2011 have been added to the two indices.

Data

Data source

The Soil and Water Quality Agri-Environmental Performance Indices are taken from Agriculture and Agri-Food Canada's Agri-Environmental Indicator Report Series – Report #4.

Spatial coverage

All indicators used in the Soil and Water Quality Agri-Environmental Performance Indices are calculated at a national scale except for the Risk of Soil Salinization Indicator, which is only calculated for the three Prairie Provinces where salinization is a major issue.

The underlying data for the indices originate from the Soil Landscapes of Canada map, the Census of Agriculture, provincial agencies, the private sector and remote sensing data sources.

Temporal coverage

Because some indicator data are drawn from the Census of Agriculture, the Soil and Water Quality Agri-Environmental Performance Indices are updated every five years on census years.

Data timeliness

The data presented in the indicators are the most current available at the time of production of these indicators. The indicator is published every 5-years following the publication of Agriculture and Agri-Food Canada's Agri-Environmental Indicator Report Series report.

Methods

A complete description of how each agri-environmental performance index is calculated is available in Agriculture and Agri-Food Canada's Agri-Environmental Indicator Report Series – Report #4.

The Soil Quality Agri-Environmental Performance Index comprises performance indicators for risk of soil erosion by wind, water and tillage; soil organic carbon change; risk of soil salinization; and contamination by trace elements:

- The Soil Erosion Risk Indicator presents the combined risk of water, wind and tillage erosion when climate, soil, topography and farming practices are considered.
- The Soil Organic Carbon Change Indicator assesses how organic carbon levels in soils are changing over time as a result of land use and management changes.
- The Risk of Soil Salinization Indicator estimates the risk of soil salinization associated with changes to land use and management practices.
- The Risk of Soil Contamination by Trace Elements Indicator considers the risk associated with arsenic, cadmium, copper, lead, selenium and zinc inputs to soil if the current use of fertilizers, manures and municipal biosolids continued for 100 years. Projected trace element concentrations, corrected for loss by leaching, crop removal and volatilization, are compared to the guideline for the health of soil organisms or human health, to estimate risk.

The Water Quality Agri-Environmental Performance Index components are performance indicators for the risk of water contamination by nitrogen, phosphorus, coliform bacteria and pesticides:

- The Indicator of the Risk of Water Contamination by Nitrogen links the amount of excess nitrogen expected to be in the soil after harvest to climatic conditions and soil characteristics to assess the risk of nitrogen leaching to surface water and groundwater.
- The Indicator of the Risk of Water Contamination by Phosphorus estimates the relative risk of agricultural phosphorus reaching surface water bodies in Canadian watersheds. It is based on estimates of source levels of phosphorus and the likelihood of phosphorus transport.

- The Indicator of the Risk of Water Contamination by Coliforms assesses the relative risk of enteric micro-organisms from agricultural sources contaminating surface water bodies using coliform bacteria as a marker.
- The Indicator of the Risk of Water Contamination by Pesticides estimates the relative risk of pesticides reaching surface- and groundwater in agricultural areas as a result of agricultural management practices, taking into account the physical-chemical properties of the pesticides.

Caveats and limitations

A full description of limitations associated with individual indicators is available in Agriculture and Agri-Food Canada's Agri-Environmental Indicator Report Series – Report #4. The limitations applying directly to the soil and water quality indices include:

- The indicator for soil contamination by trace elements was only calculated for 1981 and 2006. For all other years, an interpolated value was included in the index calculation.
- The national indices are calculated using indicator models developed at a local level, which were scaled-up to the national scale. There is little independent experimental data with which to validate or calibrate the model results.

Part 3. Annexes

Annex A. Data tables for the figures presented in this document

Table A.1. Data for Figure 1. Agri-environmental performance indices for soil and water quality in Canada, 1981 to 2011

Year	Soil Quality Agri-Environmental Performance Index	Water Quality Agri-Environmental Performance Index
1981	64	92
1986	66	87
1991	67	85
1996	70	83
2001	73	89
2006	76	82
2011	77	74

Source: Agriculture and Agri-Food Canada (2016) Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #4.

Annex B. References and additional information

References and further reading

Agriculture and Agri-Food Canada (2016) Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #4. Retrieved on July 12, 2016.

Related information

Household Use of Chemical Pesticides and Fertilizers

Wildlife Habitat Capacity on Agricultural Land

www.ec.gc.ca

Additional information can be obtained at:

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