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Data Sources and Methods for the Air Pollutant Emissions Indicators

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1. Introduction

The Air Pollutant Emissions indicators are part of the Canadian Environmental Sustainability Indicators (CESI) program, which provides data and information to track Canada's performance on key environmental sustainability issues. These indicators are also used to measure progress towards the goals and targets of the Federal Sustainable Development Strategy.

2. Description and rationale of the Air Pollutant Emissions indicators

2.1 Description

The Air Pollutant Emissions indicators track emissions of six key air pollutants from anthropogenic (human-related) sources. These air pollutants are sulphur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOC), ammonia (NH_3), carbon monoxide (CO) and fine particulate matter ($PM_{2.5}$).

For each air pollutant, the indicators are provided at the national and provincial/territorial level. They also identify the major sources of emissions and provide links to detailed information on air pollutant emissions from facilities.[1]

2.2 Rationale

Canadians are exposed to air pollutants on a daily basis that can cause adverse health and environmental effects. $PM_{2.5}$ and ground-level ozone (O_3) are key components of smog and have been associated with pulmonary and cardiovascular health issues. While causing effects of their own, NO_x (such as nitrogen dioxide [NO_2]) and VOC are the main contributors to the formation of O_3. NO_x, SO_x (such as sulphur dioxide [SO_2]), NH_3 and VOC also lead to the formation of $PM_{2.5}$ in the air, while $PM_{2.5}$ is also emitted directly. SO_x and NO_x can also lead to the formation of acid deposition that can harm the environment, materials, living organisms, and humans.

These indicators are intended to inform decision-makers and the public about progress made toward reducing emissions of key air pollutants and about the effectiveness of emission reduction measures implemented to improve ambient air quality in Canada.

2.3 Recent changes to the indicator

The Air Pollutant Emissions indicators report emission estimates that have been recalculated or updated for many different sources using improved emission estimation methods or refinements which can result in changes to historical estimates. For more information about recent changes, consult annex A2.3 of the Air Pollutant Emission Inventory Report.

Open sources such as construction operations and road dust are no longer excluded from the indicators. The inclusion of such sources makes the indicators consistent with Environment Canada's Air Pollutant Emission Inventory (APEI). However, $PM_{2.5}$ emissions indicators are reported with and without open sources. Open sources account for approximately 80% of $PM_{2.5}$ emissions. Reporting the emissions without open sources helps to provide a clearer picture of the overall impact of industrial, transportation and other sources (e.g., combustion and incineration and miscellaneous) on national $PM_{2.5}$ emissions. Removing open source emissions also provides analyses and trends that reflect the efforts of governments to reduce emissions where the majority of Canadians are the most exposed.

Total particulate matter (TPM) and respirable particulate matter (PM_{10}) are summarized but no longer detailed in the indicators. Instead, $PM_{2.5}$ has been chosen for detailed reporting because of

[1] Only those facilities that had air pollutant emissions over a certain reporting threshold were included in the National Pollutant Releases Inventory (NPRI) reported data.

its greater impact on health and its relevance to air quality standards (Canadian Ambient Air Quality Standards [CAAQS] for $PM_{2.5}$).

Provincial emissions are provided.

A new indicator on black carbon emissions has been added to the section on particulate matter. Black carbon is an airborne particle emitted directly from combustion processes in the form of $PM_{2.5}$. It has gained international attention as a short-lived climate pollutant (SLCP)[2] contributing to the warming of the Earth's surface.

3. Data

3.1 Data source

The Air Pollutant Emissions indicators used in the CESI program are based on Canada's APEI data. The APEI Report includes emissions reported by facilities to the National Pollutant Release Inventory (NPRI), as well as emissions estimated by Environment Canada using the latest estimation methods, published statistics or other sources of information such as surveys and reports. The APEI summaries and trends are compiled in collaboration with provincial, territorial and regional environmental agencies. For the interactive maps, the emissions are directly retrieved from the NPRI database.

Data for the black carbon indicator come from Canada's Black Carbon Emission Inventory. As a member country of the Arctic Council's Task Force for Action on Black Carbon (TFABC), Canada has committed to voluntarily submitting an inventory of its black carbon emissions to the United Nations Economic Commission for Europe (UNECE) by February 2015. Black carbon estimates are published separately from the APEI.

3.2 Spatial coverage

The indicators are calculated at the national and provincial/territorial, level except for black carbon, which is only available at the national level. Air pollutant emissions are also available at the facility level in the CESI interactive maps, except for black carbon.

3.3 Temporal coverage

The latest year available for the Air Pollutant Emissions indicators is 2013. Past years (1990–2012) are also available. Emissions by province and territory are reported for the years 1990, 2000 and 2013. Black carbon emissions are only reported for 2013. For facility emissions, information on key air pollutants is available for 2002 to 2013. All emissions used for the Air Pollutant Emissions indicators are annual values.

3.4 Data completeness

The APEI Report is compiled to provide the best information available on all significant sources of key air pollutants. As such, improvements to data completeness are made periodically as new emission estimation methodologies are adopted and additional information is made available. Historical emissions are also updated on the basis of these new improvements.

[2] Short-lived climate pollutants (SLCPs) are substances that have a relatively short lifespan in the atmosphere compared to carbon dioxide (CO_2) and other longer-lived greenhouse gases (GHGs). Although their life-spans are short, SLCPs are potent global warmers. Environment Canada (2015) Climate and Clean Air Coalition (CCAC) to Reduce Short-Lived Climate Pollutants (SLCPs). Retrieved on 20 January, 2015.

3.5 Data timeliness

The data are current as of December 1, 2014 for the years 1990–2013. The CESI air pollutant emissions indicators are reported approximately one year after data collection, validation, calculation and interpretation have been completed.

4. Methods

4.1 Emissions calculation and compilation

Emissions are estimated or measured through one of the following methods:

- Continuous emission monitoring systems (CEMS)
- Predictive emission monitoring (PEM)
- Source testing
- Mass balance
- Site-specific emission factors
- Published emission factors
- Engineering estimates
- Special studies

The methodologies used to estimate emissions are reviewed, updated and improved on a periodic basis. Collaborative work with sector experts from within and outside Environment Canada is undertaken to incorporate available expertise and the latest advancements in scientific knowledge. Further information on these methods is available through Environment Canada's Air Pollutant Emission Inventory website, as well as through the document entitled Air Pollutant Emission Inventory Report.

In the comprehensive emissions tables, the APEI includes four emissions sources: area, open, mobile, and point (stationary) sources. Emissions are compiled using top-down and bottom-up approaches, which are described below.

Area and open source emissions are sources too small or too numerous to be reported individually as point sources (e.g., dry cleaning, saw mills). They are usually compiled through a top-down approach using activity-level statistics and emission factors that are specific to the source. Activity levels are multiplied by emission factors to estimate the emissions for the specific source.

Mobile source (transportation) emissions are compiled using a combination of bottom-up and top-down approaches. Emissions are estimated using models that consider the number of vehicles, fuel consumed, distance travelled, technology used and many other parameters (e.g., MOBILE Canadian model).

Point source emissions are compiled through a bottom-up approach starting with emissions from facilities. The facility information reported to the NPRI is used in combination with some provincial information to compile the emissions from point sources.

The comprehensive emissions tables contain all four emissions sources (area, open, mobile and point sources). Care is taken to avoid double counting of emissions for the same source. A reconciliation of the emissions is conducted when point source emissions are already accounted for in the area source estimates. In these cases, the area source estimates are modified (reduced or removed) to avoid double counting. A data quality control process is also in place to avoid discrepancies in the database, both in data compilation and in the production of summary tables.

Canada's black carbon emissions are calculated using APEI estimates of $PM_{2.5}$ from combustion processes multiplied by black carbon ratios specific to each source, with the exception of mobile sources, where models are used. The ratios come from the United States Environmental Protection Agency's (U.S. EPA) SPECIATE database. SPECIATE is the EPA's repository of particulate matter speciation profiles[3] of air pollution sources.

4.2 Source Classification

CESI classifies emissions by summarizing emissions from multiple sources as defined in the APEI sources. Table 1 shows the allocation of air pollutant emission sources reported by CESI compared with those reported by APEI.

Table 1: Comparison of sources used in CESI and APEI

CESI sources	APEI sectors
Agriculture (livestock and fertilizer)[A]	Agriculture
Fuel for electricity and heating	Electric power generation (utilities)
	Commercial fuel combustion
	Residential fuel combustion
Home firewood burning	Residential fuel wood combustion
Incineration and miscellaneous	Crematorium
	Industrial and commercial incineration
	Municipal incineration
	Other incineration and utilities
	Cigarette smoking
	Dry cleaning
	Marine cargo handling industry
	Meat cooking
	Refined petroleum products retail
	Printing
	Structural fires
	Human
	Other miscellaneous sources
Off-road vehicles	Off-road use of diesel
	Off-road use of gasoline/liquefied petroleum gas (LPG)/compressed natural gas (CNG)
Oil and gas industry	Upstream petroleum industry
	Downstream petroleum industry
Open sources	Agriculture[A]
	Construction operations
	Dust from paved roads
	Dust from unpaved roads
	Dust from coal mining
	Waste
	Mine tailings

[3] A speciation profile is the dataset that breaks down $PM_{2.5}$ emitted from a particular source into its different components (black carbon and organic carbon). Environment Canada (2015) Canada's Black Carbon Emission Inventory. Retrieved on 15 February, 2015.

CESI sources	APEI sectors
	Prescribed burning
Other industries	Aluminum industry
	Asphalt paving industry
	Cement and concrete industry
	Chemicals industry
	Mineral products industry
	Foundries
	Grain industries
	Iron and steel industries
	Iron ore mining industry
	Mining and rock quarrying
	Non-ferrous smelting and refining industry[B]
	Pulp and paper industry
	Wood industry
	Petroleum product transportation and distribution
	Other industries
	Abrasives manufacture
	Bakeries
	Metal fabrication
	Glass manufacture
	Vehicle manufacture (engines, parts, assembly, painting)
	Electronics
	Plastics manufacture
	Food preparation
	Paint and varnish formulation
	Textiles
	Miscellaneous industrial sectors
	Biofuel production
Paints and solvents	General solvent use
	Surface coatings
Transportation (road, rail, air, marine)	Air transportation
	Heavy-duty diesel vehicles
	Heavy-duty gasoline trucks
	Light-duty diesel trucks
	Light-duty diesel vehicles
	Light-duty gasoline trucks
	Light-duty gasoline vehicles
	Marine transportation
	Motorcycles
	Rail transportation
	Tire wear and brake linings
Industry	A combination of APEI sources listed under the CESI "Oil and gas industry", and "Other industries"

[A] Agriculture is also shown as an individual source for the ammonia pollutant.

[B] Non-ferrous smelting and refining is shown as an individual source for the sulphur oxides pollutant.

For display purposes, smaller emitting sources are sometimes grouped together under the title "Other sources" in the charts of air pollutant emissions by source. The names of the sources used are listed in the notes of each chart.

5. Caveats and limitations

While the summary charts provide emissions by air pollutant including open sources, they were excluded for analytical purpose from some indicators of $PM_{2.5}$. In general, open sources for $PM_{2.5}$ are highly dependent on weather (e.g., wind, rain), and some sources are difficult to control. Also, for open sources such as road dust, fine particulate matter tends to quickly redeposit near the emission source. Open sources have been excluded in order to show the contribution of other sources that have more of an impact on the population. For more analysis with open sources, please consult the Air Pollutant Emissions Inventory Report 1990–2013.

The Air Pollutant Emissions indicators continue to evolve. Improvements are made every year to methodologies for estimating and compiling emissions summaries and analyzing trends. As a result of these improvements, emissions for a given year may be different from those previously published by Environment Canada, other governmental agencies and international organizations. Caution is advised when comparing different reports and different sources.

Some area source emissions were not updated for 2013 due to the unavailability of activity level statistics at the time of compilation. In these cases, the emission estimates from the most recent year available (2012) were used.

Canada's APEI uses point source information from the NPRI and other sources. The version of the data published by the NPRI may not be identical to that used in the APEI. Some additions and corrections are done to the point source data in the APEI.

Only the most significant sources of black carbon have been reported, representing approximately 90% of the anthropogenic black carbon emissions in Canada. Detailed analyses have not been completed for the remaining sources: the use of diesel engines for electrical generation in remote communities, commercial and residential fuel combustion (other than wood) and prescribed burning. For more information on the excluded sources, consult section 2.4 of Canada's Black Carbon Emission Inventory.

6. References and further reading

6.1 References

Environment Canada (2015) Air Pollutant Emission Inventory Report 1990–2013. Retrieved on 15 February, 2015.

Environment Canada (2014) National Pollutant Release Inventory Database. February 2014 version. Retrieved in January, 2015.

Environment Canada (2015) National Pollutant Release Inventory - Pollution Data and Reports. Retrieved in January, 2015.

Environment Canada (2015) Black Carbon Emission Inventory. Retrieved on 15 February, 2015.

Environment Canada (2015) Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (SLCPs). Retrieved on 20 January, 2015.

6.2 Further reading

Environment Canada (2015) Guide for Using and Interpreting National Pollutant Release Inventory Data. Retrieved in January, 2015.

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