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Canadian Environmental Sustainability Indicators: Air Quality Indicator: Data Sources and Methods

2005

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Note of appreciation

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1. Introduction

Canadians' health and their social and economic well-being are fundamentally linked to the quality of their environment. Recognizing this, in 2004, the Government of Canada committed to establishing national indicators of freshwater quality, air quality, and greenhouse gas emissions. The goal of these new indicators is to provide Canadians with more regular and reliable information on the state of their environment and how it is linked with human activities. Environment Canada, Statistics Canada, and Health Canada are working together to develop and communicate these indicators. Reflecting the joint responsibility for environmental management in Canada, this effort has benefited from the cooperation and input of the provinces and territories.

This report is part of a suite of documents released under the Canadian Environmental Sustainability Indicators (CESI) initiative.[1] Each indicator reported in a given year under CESI has an associated "data sources and methods" report to provide technical detail and other background that will facilitate interpretation of the indicator or allow others to build further analysis using the CESI data and methods as a starting point.

This report deals with the underlying methods and data for the *air quality indicator* as it was reported in 2005.

2. Description of the indicator

Poor air quality has significant negative effects on human health, on the natural environment, and, consequently, on economic performance. The CESI air quality indicator approximates the Canadian population's exposure to ground-level ozone. Ground-level ozone is a key component of smog and one of the most common and harmful air pollutants (other important air pollutants include fine particulates,[2] sulphur and nitrogen oxides, and carbon monoxide).

The indicator measures the seasonal average (April 1 – September 30) of the highest eight-hour average ground-level ozone concentration for each day. The indicator is designed to reflect potential health impacts attributed to ozone over the entire season, as it is not driven solely by maximum or peak observations. The indicator is population-weighted and assumes that ozone concentrations are constant within a radius of 40 km around each monitoring station.

1. http://www.environmentandresources.ca and www.statcan.ca
2. Fine particulate matter ($PM_{2.5}$) presents significant health concerns and will be included in future reports. (Liu, L. 2004)

3. How the indicator is used

The CESI initiative aims to provide Canadians with more regular and reliable information on the state of their environment and how it is linked with human activities. While the precise form of this air quality indicator has not been used before,[3] the CESI air quality indicator has been designed to approximate human population exposure to ground-level ozone over time. It is intended as a general indicator to alert policy analysts and decision-makers as to whether progress towards improved air quality is being made or if problems persist.

4. How the indicator is calculated

The calculation begins by considering successive eight-hour periods and computing the average concentration for each of these periods at a given station. The eight-hour periods are calculated ending on each hour, to give 24 eight-hour periods per day. The highest of these averages is used as the measure for that day for the given station (Figure 1). This is done for all days during the ozone season (April 1 – September 30), and the sum of these seasonal values is then averaged to produce the seasonal mean for the year for each station. Finally, the seasonal averages for the year from all the stations in Canada (or within a chosen region) are population weighted and aggregated. The national and regional results are based on the same indicator calculations.

3. Other measures of ground-level ozone are calculated with different purposes in mind. For example, air quality advisories are issued based on forecasted daily concentrations of ground-level ozone and various other pollutants. The Canada-wide Standard (CWS) for ozone, based on the three-year average of the annual fourth highest daily maximum eight-hour concentration, is designed to be an ambient air quality management target (for 2010) to be achieved by jurisdictions across Canada. CWS calculations better reflect the effects of acute (short-term) exposure to ozone, with built-in averaging to allow for year-to-year weather variations, and are a more robust target for developing emission reduction strategies. (Canadian Council of Ministers of the Environment. 2004.)

Figure 1 Graphic description of calculation of ground-level ozone maximum eight-hour average for each day (parts per billion)

Day	Hour	Hourly readings	8-hour averages	Daily maximum
Day 0	17:00:00	reading 0.18	Day 0 average #11 (of readings 0.11 to 0.18)	
Day 0	18:00:00	reading 0.19	Day 0 average #12 (of readings 0.12 to 0.19)	
Day 0	19:00:00	reading 0.20	Day 0 average #13 (of readings 0.13 to 0.20)	
Day 0	20:00:00	reading 0.21	Day 0 average #14 (of readings 0.14 to 0.21)	
Day 0	21:00:00	reading 0.22	Day 0 average #15 (of readings 0.15 to 0.22)	**Max average Day 0**
Day 0	22:00:00	reading 0.23	Day 0 average #16 (of readings 0.16 to 0.23)	
Day 0	23:00:00	reading 0.24	Day 0 average #17 (of readings 0.17 to 0.24)	
Day 1	00:00:00	reading 1.1	Day 0 average #18 (of readings 0.18 to 1.1)	Average from one 8-hour period
Day 1	01:00:00	reading 1.2	Day 0 average #19 (of readings 0.19 to 1.2)	
Day 1	02:00:00	reading 1.3	Day 0 average #20 (of readings 0.20 to 1.3)	
Day 1	03:00:00	reading 1.4	Day 0 average #21 (of readings 0.21 to 1.4)	
Day 1	04:00:00	reading 1.5	Day 0 average #22 (of readings 0.22 to 1.5)	
Day 1	05:00:00	reading 1.6	Day 0 average #23 (of readings 0.23 to 1.6)	
Day 1	06:00:00	reading 1.7	Day 0 average #24 (of readings 0.24 to 1.7)	
Day 1	07:00:00	reading 1.8	Day 1 average #1 (of readings 1.1 to 1.8)	
Day 1	08:00:00	reading 1.9	Day 1 average #2 (of readings 1.2 to 1.9)	
Day 1	09:00:00	reading 1.10	Day 1 average #3 (of readings 1.3 to 1.10)	
Day 1	10:00:00	reading 1.11	Day 1 average #4 (of readings 1.4 to 1.11)	
Day 1	11:00:00	reading 1.12	Day 1 average #5 (of readings 1.5 to 1.12)	
Day 1	12:00:00	reading 1.13	Day 1 average #6 (of readings 1.6 to 1.13)	
Day 1	13:00:00	reading 1.14	Day 1 average #7 (of readings 1.7 to 1.14)	**Max average Day 1**
Day 1	14:00:00	reading 1.15	Day 1 average #8 (of readings 1.8 to 1.15)	
Day 1	15:00:00	reading 1.16	Day 1 average #9 (of readings 1.9 to 1.16)	
Day 1	16:00:00	reading 1.17	Day 1 average #10 (of readings 1.10 to 1.17)	
Day 1	17:00:00	reading 1.18	Day 1 average #11 (of readings 1.11 to 1.18)	
Day 1	18:00:00	reading 1.19	Day 1 average #12 (of readings 1.12 to 1.19)	The maximum out of all (24) 8-hour averages calculated in a given day
Day 1	19:00:00	reading 1.20	Day 1 average #13 (of readings 1.13 to 1.20)	
Day 1	20:00:00	reading 1.21	Day 1 average #14 (of readings 1.14 to 1.21)	
Day 1	21:00:00	reading 1.22	Day 1 average #15 (of readings 1.15 to 1.22)	
Day 1	22:00:00	reading 1.23	Day 1 average #16 (of readings 1.16 to 1.23)	
Day 1	23:00:00	reading 1.24	Day 1 average #17 (of readings 1.17 to 1.24)	
Day 2	00:00:00	reading 2.1	Day 1 average #18 (of readings 1.18 to 2.1)	
Day 2	01:00:00	reading 2.2	Day 1 average #19 (of readings 1.19 to 2.2)	
Day 2	02:00:00	reading 2.3	Day 1 average #20 (of readings 1.20 to 2.3)	
Day 2	03:00:00	reading 2.4	Day 1 average #21 (of readings 1.21 to 2.4)	
Day 2	04:00:00	reading 2.5	Day 1 average #22 (of readings 1.22 to 2.5)	
Day 2	05:00:00	reading 2.6	Day 1 average #23 (of readings 1.23 to 2.6)	
Day 2	06:00:00	reading 2.7	Day 1 average #24 (of readings 1.24 to 2.7)	
Day 2	07:00:00	reading 2.8	Day 2 average #1 (of readings 2.1 to 2.8)	
Day 2	08:00:00	reading 2.9	Day 2 average #2 (of readings 2.2 to 2.9)	
Day 2	09:00:00	reading 2.10	Day 2 average #3 (of readings 2.3 to 2.10)	
Day 2	10:00:00	reading 2.11	Day 2 average #4 (of readings 2.4 to 2.11)	
Day 2	11:00:00	reading 2.12	Day 2 average #5 (of readings 2.5 to 2.12)	**Max average Day 2**
Day 2	12:00:00	reading 2.13	Day 2 average #6 (of readings 2.6 to 2.13)	
Day 2	13:00:00	reading 2.14	Day 2 average #7 (of readings 2.7 to 2.14)	
Day 2	14:00:00	reading 2.15	Day 2 average #8 (of readings 2.8 to 2.15)	
Day 2	15:00:00	reading 2.16	Day 2 average #9 (of readings 2.9 to 2.16)	
Day 2	16:00:00	reading 2.17	Day 2 average #10 (of readings 2.10 to 2.17)	
Day 2	17:00:00	reading 2.18	Day 2 average #11 (of readings 2.11 to 2.18)	
Day 2	18:00:00	reading 2.19	Day 2 average #12 (of readings 2.12 to 2.19)	
Day 2	19:00:00	reading 2.20	Day 2 average #13 (of readings 2.13 to 2.20)	
Day 2	20:00:00	reading 2.21	Day 2 average #14 (of readings 2.14 to 2.21)	
Day 2	21:00:00	reading 2.22	Day 2 average #15 (of readings 2.15 to 2.22)	
Day 2	22:00:00	reading 2.23	Day 2 average #16 (of readings 2.16 to 2.23)	
Day 2	23:00:00	reading 2.24	Day 2 average #17 (of readings 2.17 to 2.24)	
Day 3	00:00:00	reading 3.1	Day 2 average #18 (of readings 2.18 to 3.1)	
Day 3	01:00:00	reading 3.2	Day 2 average #19 (of readings 2.19 to 3.2)	
Day 3	02:00:00	reading 3.3	Day 2 average #20 (of readings 2.20 to 3.3)	
Day 3	03:00:00	reading 3.4	Day 2 average #21 (of readings 2.21 to 3.4)	
Day 3	04:00:00	reading 3.5	Day 2 average #22 (of readings 2.22 to 3.5)	
Day 3	05:00:00	reading 3.6	Day 2 average #23 (of readings 2.23 to 3.6)	
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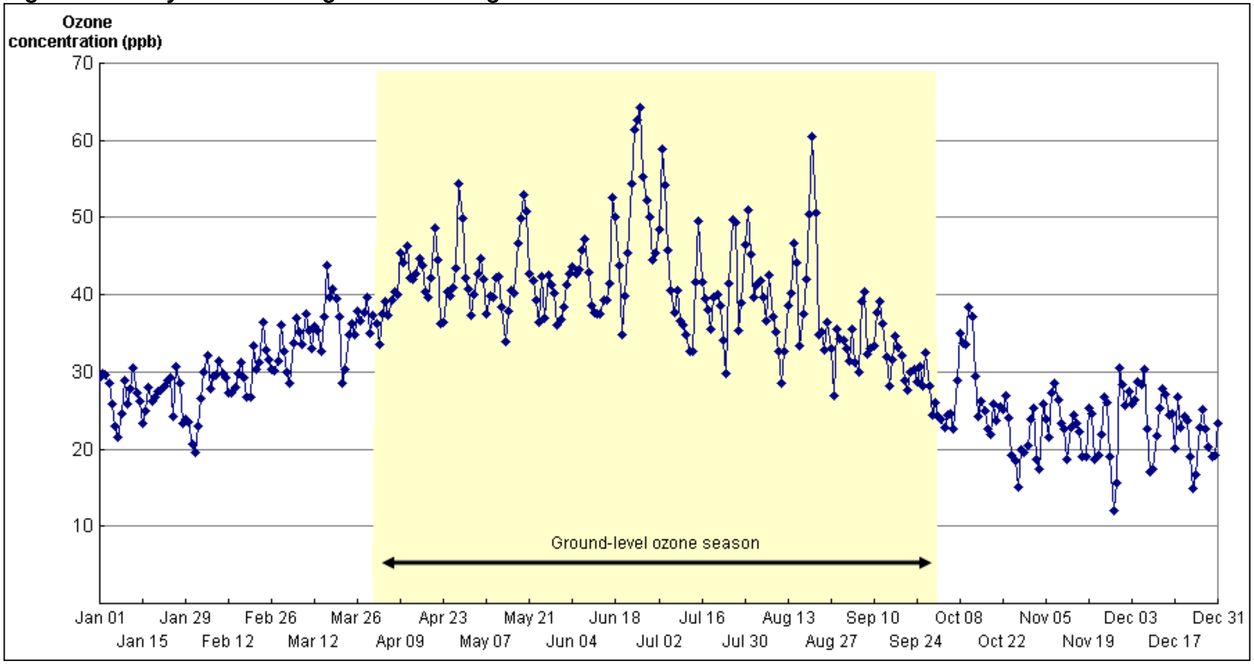
Day 3	08:00:00	reading 3.9	Day 3 average #2 (of readings 3.2 to 3.9)	
Day 3	09:00:00	reading 3.10	Day 3 average #3 (of readings 3.3 to 3.10)	

4.1 Time period

The indicator considers daily maximum eight-hour average ozone concentrations only during the ozone season (April 1 – September 30). These months tend to have meteorological conditions that favour ozone formation, while concentrations are generally lower in the winter (Figure 2).

Figure 2 Daily maximum eight-hour average ozone levels in 2003

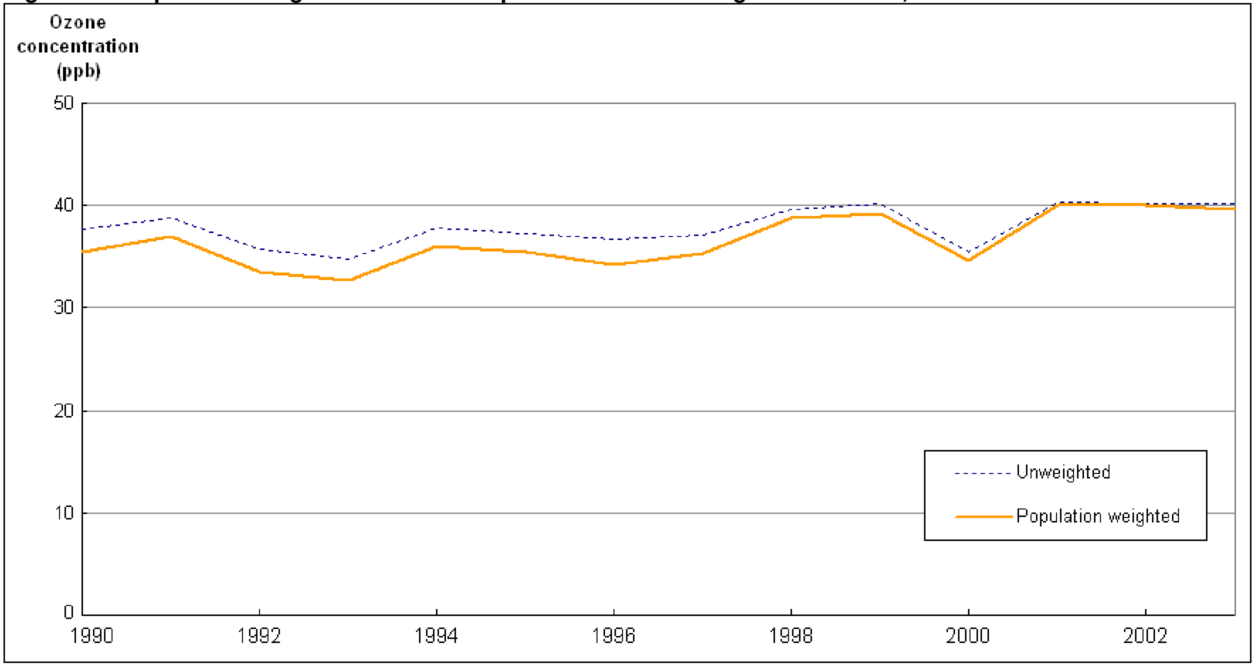


Source: Environment Canada, National Air Pollution Surveillance Network Database

4.2 Population weighting

The data from each monitoring station used in the indicator were population weighted to provide a more accurate estimation of human exposure to ground-level ozone. Three different approaches to population weighting were considered by the project team during development of the indicator.[4] The methodology chosen uses a population-weighted mean, which involves estimating the population within a certain distance (in this case, 40 km) of each station and then using that estimate to adjust the relative weight that each station is given in the analysis of averages and trends. This methodology also partially corrects the inherent bias created by the geographical distribution of the monitoring network. The net effect of this weighting is seen in Figure 3.

Figure 3 Population weighted indictor compared with the unweighted indicator, national level



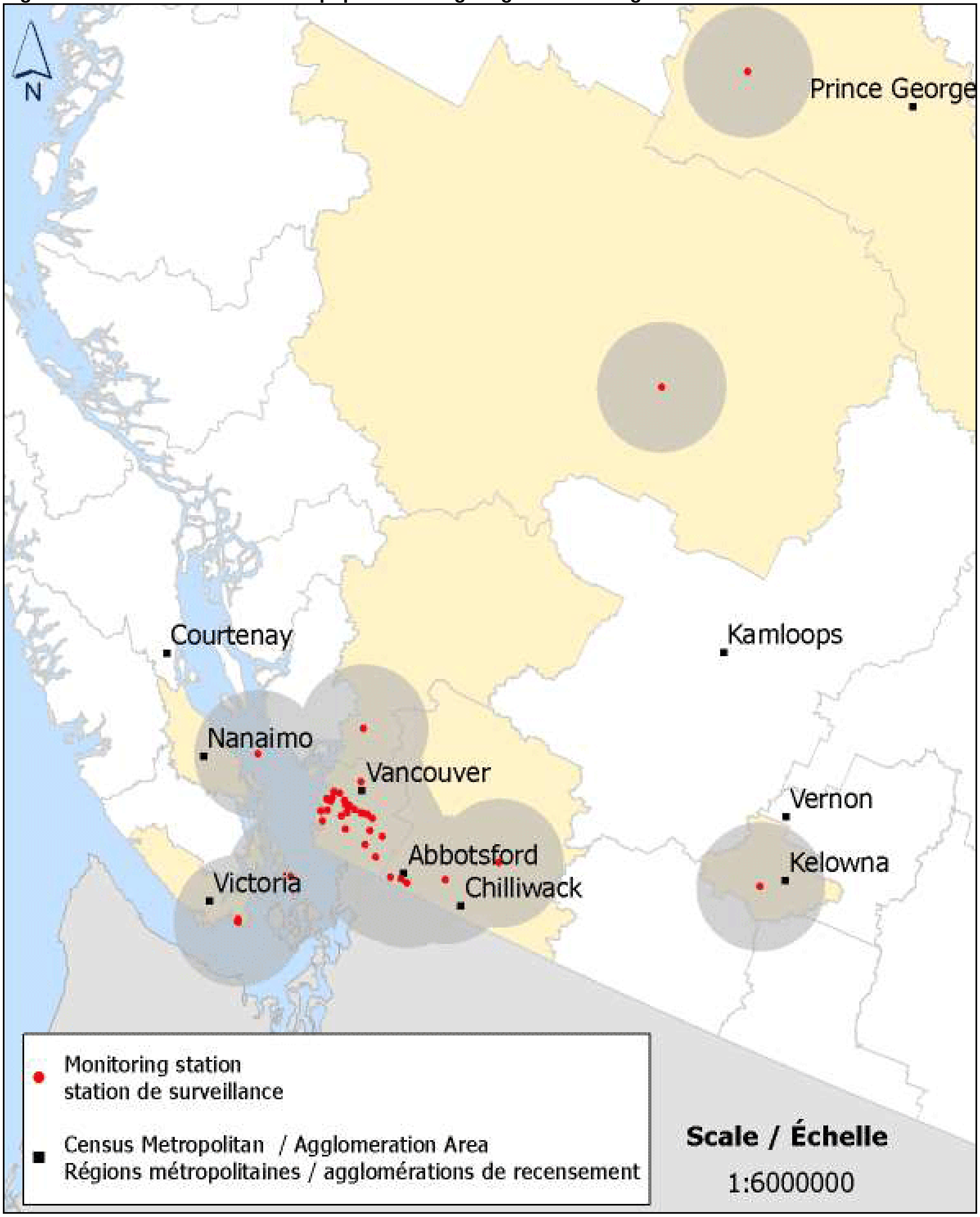
Source: Statistics Canada, Environment Accounts and Statistics Division

This indicator used data from the Census of Population. (Statistics Canada. 2002) The population size within a circular 40km zone around a given monitoring station was estimated based on the population living within the census dissemination areas (geographic areas of neighbouring blocks with a population of 400 – 700 persons) enclosed by the zone (Figure 4).[5] The boundaries of dissemination areas (DA) did not always fit precisely within zones. Where this was the case, the portion of the DA population assigned to a zone was proportional to the area of the DA found within the zone. A sensitivity analysis indicated that the size of the circular zone did not strongly

4. Alternative approaches considered included:
   - The *arithmetic mean*, which simply averages the values for all stations with sufficiently complete data. This method does not attempt to weight values by population but yields an implicit weighting based on the geographic distribution of stations within the National Air Pollution Surveillance (NAPS) network, which tends to site more stations in urban areas with higher populations.
   - The *Census area weighted mean*, which takes the average value for all monitoring stations in a Census Subdivision (equivalent to a municipality) and then weights the result by the population of the subdivision. This methodology was rejected because it may have presented complications in cases where the population distribution within Census Subdivisions did not reflect the positioning of NAPS network stations within those Census Subdivisions.
5. This approach is similar to and more general compared with the pilot method used for the National Round Table on the Environment and the Economy discussion paper on the Environment and Sustainable Development Indicators, prepared at Statistics Canada. (National Round Table on the Environment and the Economy. 2003)

affect the indicator results. Each station's weight in the overall indicator was calculated as the ratio of the population within its circular zone to the total population for all stations used in the analysis.

Figure 4 Circular zones used for population weighting of monitoring stations



Census data are only collected every five years, so linear interpolations were used to estimate the populations for intercensal years. It was assumed that population changes were constant during these five year periods. Data from the 1986, 1991, 1996, and 2001 population censuses were used in the estimates. The weights assigned to observations from individual stations changed slowly from census period to census period. Weights for 2002 and 2003 were based on linear extrapolation of the population trends for individual census dissemination areas from 1996 to 2001.

With this method, the zones for some stations overlap, which could result in a slightly heavier weighting of stations that are clustered close together. The spatial distribution of the monitoring stations will, however, affect the extent to which the full network of stations covers the Canadian population. Adjustments to account for the extent of representation of the network will be considered as part of future improvements to the indicator.

5. Data sources

Air quality monitoring stations are located across Canada and are managed by municipalities, provinces, territories and Environment Canada. Most of these stations, and all stations collecting ozone data, are organized under the National Air Pollution Surveillance (NAPS) network, a cooperative arrangement among the provinces, territories and Environment Canada that has existed since 1970. The goal of the NAPS program is to provide accurate and long-term air quality data of a uniform standard throughout Canada. Data from the NAPS program are stored in the Canada-wide Air Quality Database and are published in annual air quality data summary reports (Environment Canada. 2005). The database also includes information from the Canadian Air and Precipitation Monitoring Network (CAPMoN), run by Environment Canada. The CAPMoN stations have been established for research purposes and to monitor pollutant levels outside of urban areas.

5.1 Physical monitoring techniques

In 2003, the NAPS network consisted of 248 monitoring stations in 166 communities in Canada. In total, the stations were equipped with 644 continuous monitors measuring ozone, particulate matter, sulphur dioxide, carbon monoxide and nitrogen dioxide and 96 air samplers measuring components of particulate matter, various volatile organic compounds and other toxic substances (Figure 5). (Environment Canada. 2005)

Figure 5 Air quality monitoring station

The physical sampling equipment and procedures are standard for NAPS stations. Probes for ozone and other pollutants, for example, are sited using a set of criteria for probe height, probe distance from roadways and other sources, probe distance from airflow restrictions and probe distance from trees. (Environment Canada. 2004)

Each of the organizations participating in the NAPS network forwards data to the Environmental Technology Centre (ETC) at

Environment Canada. Since the volume of data resulting from continuous measurements would be difficult to store and manage, only hourly average readings are recorded and transmitted. After quality checking by the originating organization and by ETC, the data are available for calculating the indicator. Environment Canada has documented the processes for collecting and handling the data through the NAPS agreement. (Environment Canada. 1995)

The methods are strictly governed by operation or instruction manuals and applicable quality assurance procedures. Calibration standards used in the NAPS network are certified by the United States National Institute of Standards and Technology primary standards (Environment Canada. 2005). Analyzers (the actual mechanical/electronic equipment) that satisfy the requirements of the United States Environmental Protection Agency are selected for use in NAPS stations (see Environment Canada. 2004) for a general set of specifications related to ground-level ozone analyzers).

5.2 Data quality and completeness

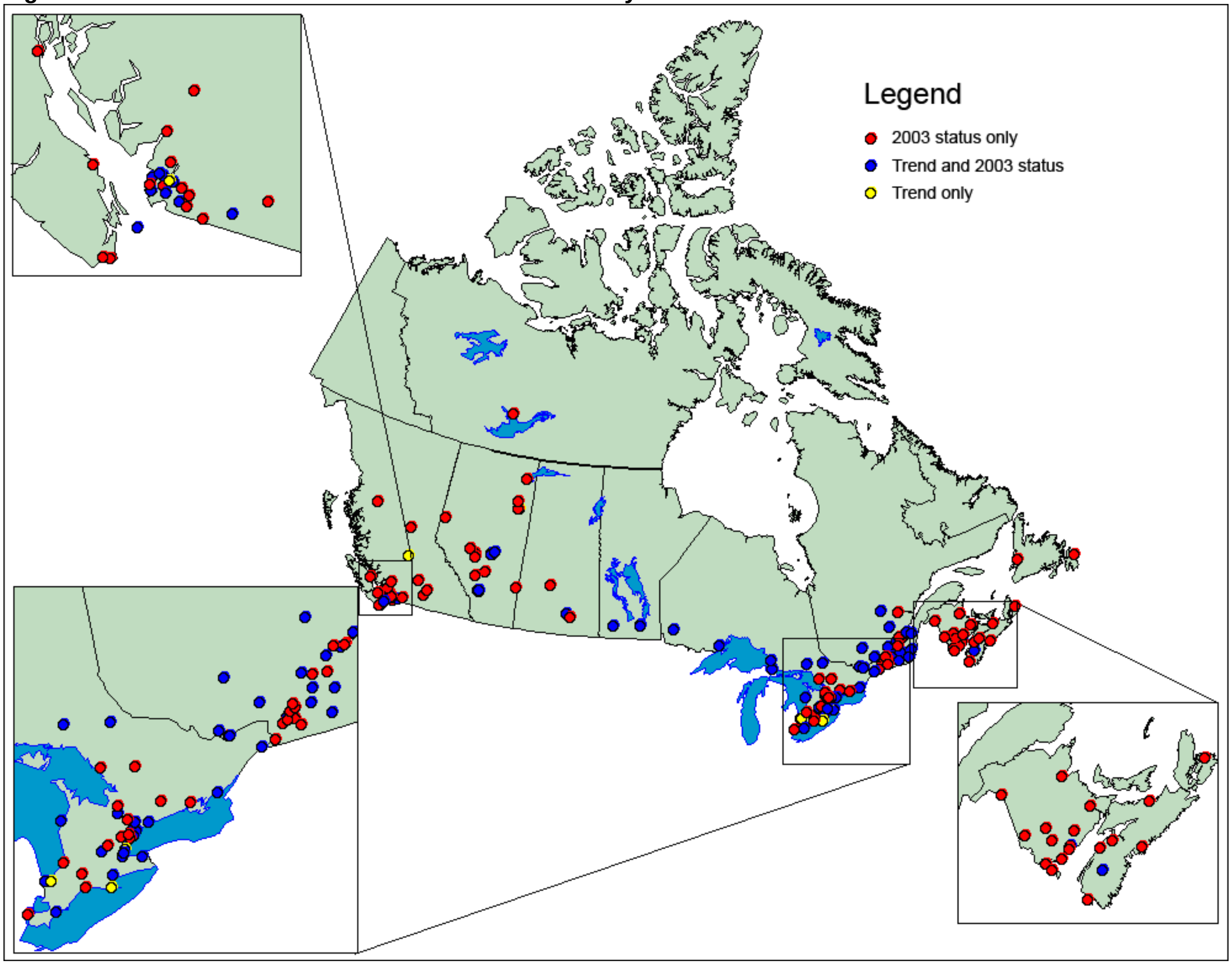
Agencies contributing to the NAPS database perform routine audits, and all strive to adhere to established quality assurance and quality control standards. Environment Canada conducts a national audit program to ensure consistency between jurisdictions across Canada. CAPMoN has adopted more rigorous standards, appropriate for a research network.

The possible measurement error for ozone concentrations at individual stations is conservatively estimated to be within ±10%. The stations do not all have the same time series of data available, nor have they all been operating continuously since 1990. There are a wide variety of reasons for this, including short-term technical problems, the commissioning or decommissioning of stations and incomplete records from some stations. Short data gaps will have little effect on computed long-period averages or trends of concentrations at individual stations. Quantitative criteria have been used to determine which observations and which stations were included in the data set used to estimate the indicator, as follows:

- Each eight-hour period must have data for six or more hours.
- Each day must have data for at least 18 of the 24 eight-hour periods.
- Each season must have values for at least 75% of days. For the ozone season (April 1 – September 30), 138 of the 183 days are required.
- To be included in the time series, stations must have yearly seasonal values for 75% or more of the years. For 1990–2003, this means 11 of the 14 years.
- Stations missing more than two consecutive years at the start or end of the period are excluded to avoid using data from stations commissioned or decommissioned during the period.

As a result of applying the criteria for data completeness, 79 stations had sufficient data for the national trend analysis (1990-2003), 74 were used for regional trend analysis and 154 were used for the 2003 snapshot (Figure 6).

Figure 6 Distribution of NAPS stations used in the analysis



Aggregates of data that just meet the completeness criteria will tend to have a higher standard error than estimates based on a larger and more complete set of data. Overall, there is very high variability in ozone concentrations among locations, as well as within and among years.

5.3 Spatial coverage of data

Air quality monitoring stations are spread across the country, but are concentrated more heavily in urban areas. The monitoring stations used in this report cover about 65% of Canada's population. As the NAPS network encompasses stations that have been established for differing needs, the distribution of the network is not systematic. Each participating NAPS partner has established its own networks and groupings of monitoring stations to track regional or urban conditions.

Stations usually track multiple pollutants and are not always ideally sited for ozone monitoring purposes. Some stations were intended to measure the effects of specific activities, such as an industrial plant or highway, rather than to be representative of the air quality for the general area. When the stations were subject to local, unrepresentative influences, readings were excluded from the indicator calculation. NAPS data analysts eliminated four stations to minimize bias in the readings (Table 1). Additional stations would have been excluded for special circumstances, but did not meet the criteria for data completeness in the first place.

Table 1 Excluded monitoring stations

Station (NAPS identification code and location)	Reason for exclusion
50115, Montreal, Quebec	High levels of NO_X scavenging[a]
60101, Ottawa, Ontario	High levels of NOx scavenging
100112, Greater Vancouver Regional District, British Columbia	High levels of NO_X scavenging
91201, Hightower Ridge, Alberta	High elevation of the station

[a] "NO_X" is a term applied to the sum of nitric oxide and nitrogen dioxide (NO plus NO_2) as a chemical family. Reversible conversion of one of these oxides of nitrogen to the other is common in the atmosphere, in a reaction usually involving ozone. Operational networks actually measure NO and NO_X, with NO_2 computed as a difference. At the low concentrations typical of rural areas, NO_X makes a net positive contribution to photochemical ozone formation, but at the higher concentrations typical to urban centres the balance is shifted to ozone consumption, so that higher transportation emissions can decrease ozone locally. This phenomenon is referred to as NO_X scavenging. Sites too close to high traffic areas are not considered representative of the broader population exposure, but are maintained for other purposes.

5.4 Timeliness

The data used in this report have gone through quality assurance and quality control procedures to ensure that they adhere to Environment Canada and partner guidelines. At present, there is a time lag of nine months from the end of a calendar year before the raw monitoring data[6] are verified, compiled, and available for calculating the national indicator. Improvements are planned to reduce this time lag to less than six months.

6. Statistical analysis

For the 2005 CESI report, three sets of information were provided: a summary by monitoring station based on 2003 concentrations; yearly national values and trend based on a subset of stations for which sufficient data were available; and regional trends.

6.1 Summary of ozone concentrations for 2003

The distribution of the average eight-hour maxima is approximately normal. These values can be used in statistical analysis without additional statistical transformation.

6.2 National trend analysis

Daily observations from all stations and years that met the completeness criteria were used to ensure that all adequate sources of monitoring data are included in the regression analysis. A linear regression line showed an estimated increase of 0.4 parts per billion (ppb) per year, or an estimated 16% increase from 1990 to 2003 (Table 2).

6.3 Regional trend analysis

The monitoring stations were grouped into five clusters for the regional trend analysis. The British Columbia region includes only stations inside the Greater Vancouver Regional District and the Lower Fraser Valley. One station in central British Columbia and four in northeastern Ontario were included in the national trend analysis, but were not assigned to any region for the regional analysis.

The results of the regional trend analysis are summarized in Table 2.

6. Raw data collected by the monitoring network feeds directly into smog alerts, daily smog reports, and various air quality indices that are issued by cities, provinces and the Meteorological Service of Environment Canada. Having immediate data available for these purposes is considered more important than the risk posed by potential errors in the unverified data.

Table 2 Summary of statistical analysis of trends in population-weighted ozone concentrations

Region	Estimated mean annual change (ppb)	95% confidence interval (ppb)
National	+0.4	(+0.1 to +0.7)
Southern Ontario	+0.7	(+0.3 to +1.1)
Quebec and Eastern Ontario	+0.5	(+0.1 to +0.8)
Prairies and Northern Ontario	*	(-0.1 to +0.5)
Atlantic	*	(-0.5 to +0.7)
British Columbia	*	(-0.1 to +0.3)

* Indicates that there is no explicit increase or decrease that can be reported.

7. Caveats and limitations to the indicator and data

- *Measurement error*: With respect to the monitoring instruments, the quality assurance and quality control procedures previously noted ensure that sources of measurement error are minimized.

- *Data completeness*: The criteria for determining whether stations have sufficiently complete data to be used in the indicator analysis are based on expert opinion; a full analysis of the different sources of error has not yet been conducted. A more inclusive trend analysis could be based on relaxing the data completeness criteria and rely on statistical and analytical tools to compensate for missing values.

- *Regional divisions*: Similarly, the definitions of the regions used for reporting in 2005 were based on general regional patterns and the expert judgement of Environment Canada scientists. Different regional boundaries could be established based on a more detailed analysis of regional ozone concentrations and weather patterns.

- *Population weighting*: The method used for the 2005 report is a preliminary approach to population weighting. Further work is needed to more accurately account for the uneven distribution of monitoring stations across the country in relation to population. The methodology could also benefit from a more sophisticated way of estimating the area that is represented by a given station.

- *Trend analysis*: Despite the statistical significance of the national and regional trends reported in 2005, the statistical analysis does not yet explain most of the variation in ozone concentrations. Significant differences in year-to-year variability, which are important to track, are averaged out within the trend analysis. A more detailed description of the daily and seasonal cycles in ozone levels could improve the completeness of the statistical analysis. This would be useful for understanding how the indicator responds to weather changes (e.g. sunlight and temperature) compared with changes in sources of pollutants and other influences.

8. Future improvements

The air quality indicator builds on the base of an established national monitoring network. However, ozone levels are influenced by complex factors, including weather and transboundary flows of pollutants. The approach taken in this report — analyzing the observed concentration in relation to where people live — is just a start. It will benefit from refinements in future reports. As well, ground-level ozone is only one component of air pollution. Systematic measurements of other pollutants, especially fine particulate matter, will need to be analyzed. Their cumulative effect must then be integrated into a comprehensive air quality and health indicator.

The following improvements are planned for the air quality indicator:

- *Indicator*: The 2006 report will include a measure of fine particulate matter ($PM_{2.5}$), which is another key component of smog that presents significant health risks for Canadians.

  Health Canada scientists are examining the feasibility of a broader indicator based on the health risk caused by exposure to a combination of several air pollutants. This should provide a more comprehensive picture than examining pollutants individually. (Burnett et al. 2005) This indicator would be based on linking deaths and hospitalizations due to heart and lung problems with air pollutants present at particular locations and times. The indicator would incorporate ground-level ozone, fine particulate matter, nitrogen dioxide and sulphur dioxide. By focusing on the association between exposure and consequences — deaths or hospitalizations — the new indicator would reflect changes over time in both exposure and health risks, the latter potentially attributable to changes in population susceptibility (e.g., due to aging) or the nature of the air pollution mix.

- *Monitoring*: Environment Canada will continue to invest in new instruments to fill gaps in pollutant coverage at existing monitoring facilities and will establish new stations. Further investment will include new instruments for both ozone and particulate matter. While new stations in more remote locations will not strongly influence the population-weighted indicator, they will help to monitor background levels and improve understanding of the complete data set. The networks will also be assessed for improvements to better measure the ozone concentrations that affect the population. For the purposes of this indicator, the monitoring network should ideally provide a balanced coverage of the Canadian population to best represent their exposure to ground-level ozone.

- *Analysis*: Ground-level ozone observations weighted by population are being used on an interim basis for the air quality indicator. Future work will examine improvements to this method. For the trend analysis, use of the non-parametric Sen method will be assessed as a replacement for the linear regression method.

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