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Data Sources and Methods for the International Comparisons of Urban Air Quality Indicators

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1 Introduction

The international comparisons of urban air quality indicators are a part of the Canadian Environmental Sustainability Indicators (CESI) (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=47F48106-1) program, which provides data and information to track Canada's performance on key environmental sustainability issues.

These international air quality indicators are similar to Canada's air quality indicators, which report on ambient ozone (O_3), fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) concentrations at the local, regional and national scales. For an international comparison, this indicator reports on air quality in Canadian urban centres compared with other urban centres around the globe.

2 Description and rationale of the international comparisons of urban air quality indicators

2.1 Description

The international urban air quality indicators present, for 2010, ambient ground-level ozone (O_3) concentrations based on the average of the 8-hour daily maximum concentrations, and fine particulate matter ($PM_{2.5}$), ambient sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) concentrations based on the 24-hour daily average concentrations. A comparison of air quality among Canadian and international urban areas is presented.

The international urban areas compared are members of the Organisation for Economic Co-operation and Development (OECD) and they are selected on the basis of data availability and population size. Ozone levels are provided for 32 urban areas, $PM_{2.5}$ levels for 30 urban areas, SO_2 levels for 31 urban areas and NO_2 levels for 32 urban areas.

An "urban area" is defined as an area with a high density concentration of population. Urban area definitions vary from one country to another. An urban area in this document refers to a city, a town, a group of cities (metropolitan area) or a region

2.2 Changes since last report

Five new international urban areas were added to the analysis because sufficient O_3 or $PM_{2.5}$ data had become available. These urban areas have population sizes that are comparable to Canadian urban areas. The following urban areas were added: Sofia, Warsaw, Hamburg, Bucharest and Lyon.

One urban area (Perth, Australia) was removed from the comparison as it no longer met the data completeness selection criteria. Another urban area (Helsinki) was not used for the comparison because data was not available at the time of the production of this document. This is the first time that the SO_2 and NO_2 indicators are being reported as part of the Canadian Environmental Sustainability Indicators (CESI).

3 Data

3.1 Data source

Air quality data for the international comparison came from a variety of databases, including the following: the Canada-wide air quality database, the European Union's (EU's) AirBase Viewer Database (EU) (http://www.eea.europa.eu/themes/air/airbase) and the United States Environmental Protection Agency's (U.S. EPA's) Air Quality System (AQS) (http://www.epa.gov/ttn/airs/airsaqs/). Some data for individual urban areas came from their country's annual air quality reports or websites (Sydney and Paris for the selection of station). Population data were retrieved only from government-affiliated (national) sources. For a complete list of all the data sources, refer to Section 6 References and further reading.

3.2 Spatial coverage

The data cover urban areas in Canada, the United States and selected member countries of the Organisation for Economic Co-operation and Development (OECD).

3.3 Temporal coverage

The values used for the indicators are calculated for the year 2010.

3.4 Data completeness

The international urban areas chosen for the indicators were selected because they have urban populations similar to six of Canada's largest urban areas (i.e. having an urban population of over one million) and because of the availability of data.

For any given O_3 and $PM_{2.5}$ monitoring station to be used for an urban area's calculations, at least 75% of its data for the year needs to be available for inclusion. This criterion was applied at the hourly, daily and yearly time periods.

An SO_2 or NO_2 monitoring station used in an urban area's calculations is included only when

- each day has data for at least 18 hours;
- each month has data for at least 50% of valid days;
- each quarter (3 months) has data for at least 2 valid months; and
- each year has 4 valid quarters.

3.5 Data timeliness

The gap between a given year and publication of data for that year varies considerably among urban areas. For some urban areas, annual data is available within a few months of a reported year while, for others, the quality assurance and control process is lengthier.

For population data, timeliness varies considerably—some countries or cities only publish in census years, whereas others publish yearly estimates.

4 Methods

Concentrations data were taken directly from various air quality monitoring networks and agencies. Data were either copied from reports or downloaded. In some cases, concentrations

data were found in the needed format and did not require any further modifications. In other cases, these data were unavailable in the required format. The concentrations data by monitoring station (hourly measurements) were used to calculate the average concentrations.

For O_3, the annual average 8-hour daily maximum was calculated. For $PM_{2.5}$, SO_2 and NO_2, the annual 24-hour mean was calculated for each station found within urban city boundaries. The annual values from each monitoring station in the urban area boundary were then averaged. Each station was equally weighted and the data were not population-weighted.

O_3, SO_2 and NO_2 levels were reported in several units (i.e. ppb, ppm and $\mu g/m^3$). In order to provide readers with a more clear and compatible comparison, all international units were converted to ppb. Internationally, $PM_{2.5}$ is measured in $\mu g/m^3$; therefore, no conversion was necessary.

5 Caveats and limitations

Caution must be taken when comparing air quality from different urban areas. Beyond population, other factors such as climate, geography, local emissions, transboundary pollution and elevation do influence air pollution. Technical and methodological factors such as the type of monitoring equipment used, station location and number of stations for a single urban area can also influence the results of the comparison.

For example, the fine particulate matter ($PM_{2.5}$) monitors in Montréal, Calgary and Edmonton are based on newer technologies than monitors in other Canadian cities. These newer methods measure a portion of the $PM_{2.5}$ (semi-volatile) mass that was not captured by the older instruments.

Many monitoring stations were not selected because they did not meet the selection criteria (75% of data, hourly, daily). However, data from neighbouring stations were sometimes grouped and used to supplement missing data and produce yearly values that met the selection criteria. This imputation method was used for some stations in Seattle and Phoenix for the calculation of the $PM_{2.5}$ values.

O_3, $PM_{2.5}$, SO_2 and NO_2 concentrations for some cities were not reported because

- the concentrations did not meet Environment Canada selection criteria; or
- the available annual data were not available in the same metrics used for the comparison; or
- the hourly data were not available to estimate the annual concentrations.

6 References and further reading

Air quality data :

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