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

January 2014

Canada

ISBN: 978-1-100-23012-2
Cat. No.: En4-144/43-2013E-PDF

Aussi disponible en français.

1 Introduction

The International Comparisons of Urban Air Quality indicators (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=FDBB2779-1) are a part of the Canadian Environmental Sustainability Indicators (CESI) program (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=47F48106-1), which provides data and information to track Canada's performance on key environmental sustainability issues.

While Canada's air quality indicators report the concentration of ozone (O_3), fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) at the local, regional and national scales, the International Comparisons of Urban Air Quality indicators compare these same pollutants in Canadian urban areas against that of urban areas of other countries.

2 Description and rationale of the International Comparisons of Urban Air Quality indicators

2.1 Description

The International Comparisons of Urban Air Quality indicators (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=FDBB2779-1) compare ambient levels (concentrations) of air pollutants in Canadian urban areas with levels in urban areas from other countries. The indicators report the concentration of ozone (O_3) (as the 2011 average of the 8-hour daily maximum) and fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) (as the 2011 average of the 24-hour daily average) in ambient air.

2.2 Rationale

$PM_{2.5}$ and ground-level O_3 are key components of smog and two of the most widespread air pollutants to which people are exposed. NO_2 and volatile organic compounds (VOC) react in the presence of sunlight and warm stagnant air to produce ground-level O_3. NO_2 and SO_2 contribute also to the formation of $PM_{2.5}$ and contribute to acid deposition. Exposure to air pollution, even at low concentrations, has been linked to a number of adverse effects on health (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=CB7B92BA-1). These indicators are intended as environmental state/condition indicators to inform decision-makers and the public about progress toward improved ambient air quality. These indicators are also intended to provide a general comparison of ambient levels of air pollutant for different urban areas and show how the Canadian urban areas fare compared to other international ones.

3 Data

3.1 Data sources

The ambient levels of air pollutants used in the international comparison were obtained primarily from four databases:

- Canada: the Canada-wide air quality database (CWAQD) (http://www.etc-cte.ec.gc.ca/napsdata/Default.aspx) from the National Air Pollution Surveillance network (NAPS) (http://www.ec.gc.ca/rnspa-naps/default.asp?lang=En&n=5C0D33CF-1).
- Europe: AirBase, the European Air Quality database (http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-7) from the European Environmental Agency (EEA).
- United States: the Air Quality System database (AQS) (http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsdata.htm) from the United States Environmental Protection Agency (U.S. EPA).
- Sydney, Australia: Air Quality Data Search (http://www.environment.nsw.gov.au/AQMS/search.htm) from the Office of Environment and Heritage of New South Wales, Australia.

Urban area populations were retrieved from the following sources:

- Canada: Statistics Canada (2013) Population of census metropolitan areas (http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo05a-eng.htm). Retrieved on June, 2013.
- Europe: European Commission (2013) Regions, Metropolitan regions and Cities Eurostat Database (http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/introduction). Retrieved on June, 2013.
- United States: U.S. Census Bureau (2013) Metropolitan and Micropolitan Statistical Area Estimates (http://www.census.gov/popest/data/metro/totals/2012/). Retrieved on June, 2013.
- Australia: Australian Bureau of Statistics (2013) Population Estimates by Statistical Area Level 2 (http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3218.02011-12?OpenDocument). Retrieved on June, 2013.

3.2 Spatial coverage

Air quality in urban areas in Canada, the United States and selected member countries of the Organisation for Economic Co-operation and Development (OECD) are compared. Urban areas were included in the indicators if they met the population size and data availability criteria, including the data completeness criteria provided in Section 3.4.

For the purpose of these indicators, an urban area is a city, group of cities (metropolitan area) or region with a population greater than 1 million. More specifically, an urban area corresponds to the census metropolitan area (CMA) for Canadian cities (http://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo009-eng.cfm). For urban areas in the United States we used the metropolitan areas (MA) (http://www.census.gov/population/metro/data/metrodef.html). For the European countries we used different urban areas corresponding to the areas covered by the available monitoring

stations. We limited ourselves to three different urban areas: metropolitan region (http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/metropolitan_regions), large urban zone and core city (http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/city_urban/spatial_units) . For Sydney we used their greater capital city statistical area (GCCSA) (http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/2901.0Chapter23102011).

3.3 Temporal coverage

The indicators were calculated with concentrations measured throughout the year 2011.

3.4 Data completeness

The urban areas compared in these indicators have populations that are comparable to Canada's six largest urban areas.

For any given ozone (O_3) and fine particulate matter ($PM_{2.5}$) monitoring station to be used in the calculation of concentrations for a particular urban area, measurements covering at least 75% of the year were required. This criterion was applied at the hourly, daily and yearly time periods.

A sulphur dioxide (SO_2) or nitrogen dioxide (NO_2) monitoring station was used in the calculation of concentrations for an urban area only if data were available for at least:

- 18 hours per day (valid day);
- 50% of valid days per month (valid month);
- 2 valid months per quarter; and
- 4 valid quarters per year.

Ozone levels are provided for 32 urban areas, $PM_{2.5}$ levels for 30 urban areas, SO_2 levels for 28 urban areas and NO_2 levels for 32 urban areas.

3.5 Data timeliness

The gap between a given year and publication of air pollutant level data for that year varies considerably among urban areas. For some urban areas, annual data is publically available within a few months of a reported year while, for others, the data validation is lengthier. 2011 was selected as the latest year of data to accommodate the variation in data timeliness.

For population data, timeliness varies considerably among urban areas, as some countries or cities only publish in census years, whereas others publish annual estimates. Population data are for years ranging from 2006 to 2012.

4 Methods

Air pollutant concentrations were obtained from the air quality monitoring networks and agencies listed in section 3.1. For ozone (O_3), the 8-hour daily maximum concentration was used. For particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2), the 24-hour daily average concentrations were used. Hourly measurements were used to calculate the annual average for each station. Stations ambient levels were averaged to obtain the value reported for each urban area. Each station was equally weighted and the data were not population-weighted.

Concentrations were converted to parts per billion (ppb) when necessary. This was the case for O_3, SO_2 and NO_2 levels, as they were reported in different units in different jurisdictions (i.e. parts per billion (ppb), parts per million (ppm) and micrograms per cubic metre ($\mu g/m^3$)). The conversion from $\mu g/m^3$ assumed 25°C and 1 atmosphere (atm). $PM_{2.5}$ is measured, in each jurisdiction, only in $\mu g/m^3$; therefore, no unit conversion was necessary for this pollutant.

5 Caveats and limitations

Caution must be taken when comparing air quality among urban areas. Differences in monitoring equipment, in the rationale behind placement of stations, and in the number of stations can influence the comparability of concentrations from different urban areas. 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 urban areas. These newer methods measure a portion of the $PM_{2.5}$ (semi-volatile) mass that was not captured by the older instruments.

Although population is provided as a means of comparing the urban areas in these indicators, the particular climate, elevation and geography, along with local emissions and inputs of transboundary pollution, influence the level of air pollution in each urban area.

6 References and further reading

Air Pollutant Concentration Data

Environment Canada (2013) Canada-wide air quality database (CWAQD) from the National Air Pollution Surveillance network (NAPS). Retrieved in April, 2013. Available from: http://www.etc-cte.ec.gc.ca/napsdata/Default.aspx.

European Environment Agency (2013) AirBase - The European air quality database. Retrieved in May, 2013. Available from: http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-7.

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United States Environmental Protection Agency (2013) AQS Data for Downloading. Retrieved in May, 2013. Available from: http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsdata.htm.

Population Data

Australian Bureau of Statistics (2013) Population Estimates by Statistical Area Level 2. Retrieved in June, 2013. Available from: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3218.02011-12?OpenDocument.

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