Annual NO_2 Supplementary Methods Documentation
April 2020

1. Considerations for Data Users

The annual NO_2 estimates from 1984 to 2012 have been derived from models based on annual measured NO_2 levels from National Air Pollution Surveillance monitoring stations for 24 Census Divisions. These annual estimates were calculate by applying factors derived from annual observed measures from the National Air Pollution Surveillance (NAPS) monitors to the results of a land use regression (LUR) model developed by Dr. Perry Hystad circa 2006 (the base year)[1]. In effect, these factors either raise (for years prior to 2006) or lower (for years after 2006) all NO_2 estimates from the LUR model by the same amount for a given year within each region.

The annual NO_2 estimates from 2013 to 2016 have been derived from provincial average of annual measured NO_2 levels from National Air Pollution Surveillance monitoring stations that were classified as general population exposure and regional background. These annual estimates were calculated by applying factors derived from annual observed NO_2 measures from the National Air Pollution Surveillance (NAPS) monitors to 2012 annual NO_2 estimates that was derived from modelled values for 24 Census Divisions (i.e. NO2LUR_A_12.csv).

The approach used to derive the 2012 annual NO_2 estimates (i.e. NO2LUR_A_12.csv) inherently allows for the potential that over time NO_2 levels changed at a different rate across Canada. Taking into consideration these geographic differences in temporal adjustments is important because they can impact the magnitude of exposure gradients between people in different areas depending upon year.

It was assumed that using the 2012 annual NO_2 estimates rather than the 2006 annual NO_2 estimates[1] as the base year would be a better representation of spatial gradients as the former estimates account for changes in emission sources between 2006 and 2012 by incorporated geographic differences in temporal adjustments

2. Calculating annual factors

For each Province, CANUE Staff used the below equation to calculate an annual predicted NO_2 level for 2013 to 2016 (shown in column A in Table 1), then the ratio of each year's predicted level compared to the 2012 predicted level was calculated (shown in column C in Table 1). For each Province, annual factors were calculated for each year (2013 - 2016). Note that the ratio method for producing annual factors has been used previously in Canada[2] and Europe[3].

$$Annual\ Predicted\ \mathrm{NO2} = \frac{Average\ NO2\ level\ from\ NAPS\ stations\ in\ province, P, for\ year,\ Y}{Average\ NO2\ level\ from\ NAPS\ stations\ in\ province, P, for\ year,\ 2012}\ x\ 2012\ Annual\ Predicted\ NO2\ level$$

It should be noted that only National Air Pollution Surveillance monitoring stations that were classified as general population exposure and regional background were used in deriving the annual factors.

3. Applying the annual factors

Using the 2012 estimates that were based on the 2006 NO_2 model, estimates of annual average NO_2 (ppb) were made for every single-link DMTI Spatial Inc postal code location in use in 2012 by Dr. Perry Hystad, Oregon State University. CANUE staff assigned each postal code a province ID, and applied the appropriate province-specific annual factors, resulting in 4 annual files (2013-2016) containing NO_2 estimates.

Table 1. Calculation example for Province ID, 35 (Ontario), for 2012-2016

Year	A Annual predicted NO_2 level	B 2012 predicted NO_2 level	C Annual factor Ratio A/B
2016	16.3	18.6	0.88
2015	17.4	18.6	0.93
2014	17.7	18.6	0.95
2013	17.3	18.6	0.93
2012	18.6	18.6	1

References:

1. Hystad, P. et al. Creating National Air Pollution Models for Population Exposure Assessment in Canada. Environ. Health Perspect. 119, 1123–1129 (2011).

2. Chen, H. et al. Back-extrapolation of estimates of exposure from current land-use regression models. Atmos. Environ. 44, 4346–4354 (2010).

3. Beelen, R. et al. Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. The Lancet 383, 785– 795 (2014).