

# **AQBAT - Estimating Health Impacts for Changes in Canada's Air Quality**

Stan Judek and Dave Stieb

Biostatistics and Epidemiology Division  
Health Canada

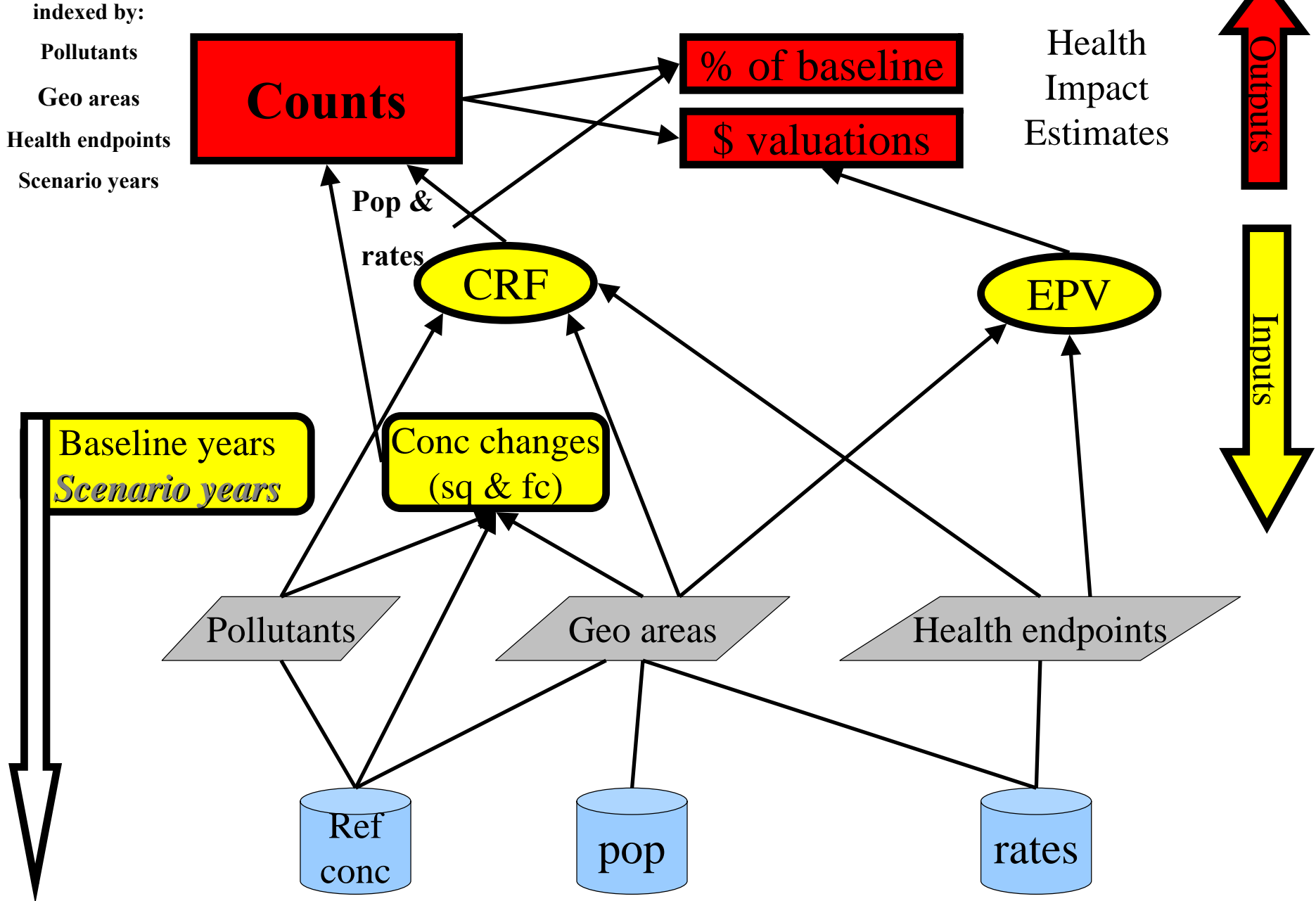
[stan\\_judek@hc-sc.gc.ca](mailto:stan_judek@hc-sc.gc.ca)

[dave\\_stieb@hc-sc.gc.ca](mailto:dave_stieb@hc-sc.gc.ca)

# Air Quality Benefits Assessment Tool (AQBAT)

- a computer simulation **tool** designed to estimate the human health and welfare benefits or damages associated with changes in Canada's ambient air quality
- successor to the Air Quality Valuation Model (AQVM)
- Consists of one Excel file containing Excel User Forms and VBA programming to control the defining and running of a scenario model, along with...
- database files of pollutant concentrations, population counts and health endpoint rates, and...
- @Risk add-in, accessed and controlled by AQBAT programming, to perform the Monte Carlo simulation and track the outputs

# AQBAT Schematic



**Thank You**

**Merci**

**Dziękuję**

# Concentration Response Functions (CRFs)

- what is the % excess health endpoint associated with a unit increase in a pollutant concentration
  - statistically derived from epidemiological studies
  - have an [uncertainty](#)
- nucleus of AQBAT
  - User decides which pollutant-endpoint combinations will be assigned a CRF, and for which set of geographic areas
  - CRFs collectively determine which pollutants, health endpoints and geographic areas are in the scenario model
  - [User form example](#)



# Pollutant concentration changes

- from a baseline or reference set of concentrations
  - status quo and forecast
- User can define a concentration change for a geo area as a
  - % reduction (e.g. 25% reduction of annual mean  $PM_{2.5}$ )
  - absolute reduction (e.g. 1 ppm decrease in the annual mean for CO)
  - reduction to target (e.g. reduction of annual mean to 40 ppb  $O_3$ )
  - [other flexibilities](#)
- typically with Atmospheric Modeling
  - reference to sq target concentrations (baseline, without policy)
  - reference to fc target concentrations (with policy)



# Fundamental AQBAT Calculation

## Concentration Response function

*(assigned to geographic areas for a specific pollutant and endpoint)  
(expressed as % excess adverse endpoints per unit concentration of pollutant)*

x

## Pollutant concentration change

*(user inputs as either % or absolute or target)  
(AQBAT processes as absolute change)*

x

## Baseline rate of incidence of the health endpoint in the population

*(e.g. deaths per million population)*

x

## Population

*(in millions)*

=

## Number of excess effects attributable to pollutant change

x

Valuation concepts (societal value (\$) of change in health risk)



$$\begin{aligned} & \% \text{ of baseline} \\ & = \\ & \text{Count} / (\text{pop} \times \text{rate}) \end{aligned}$$

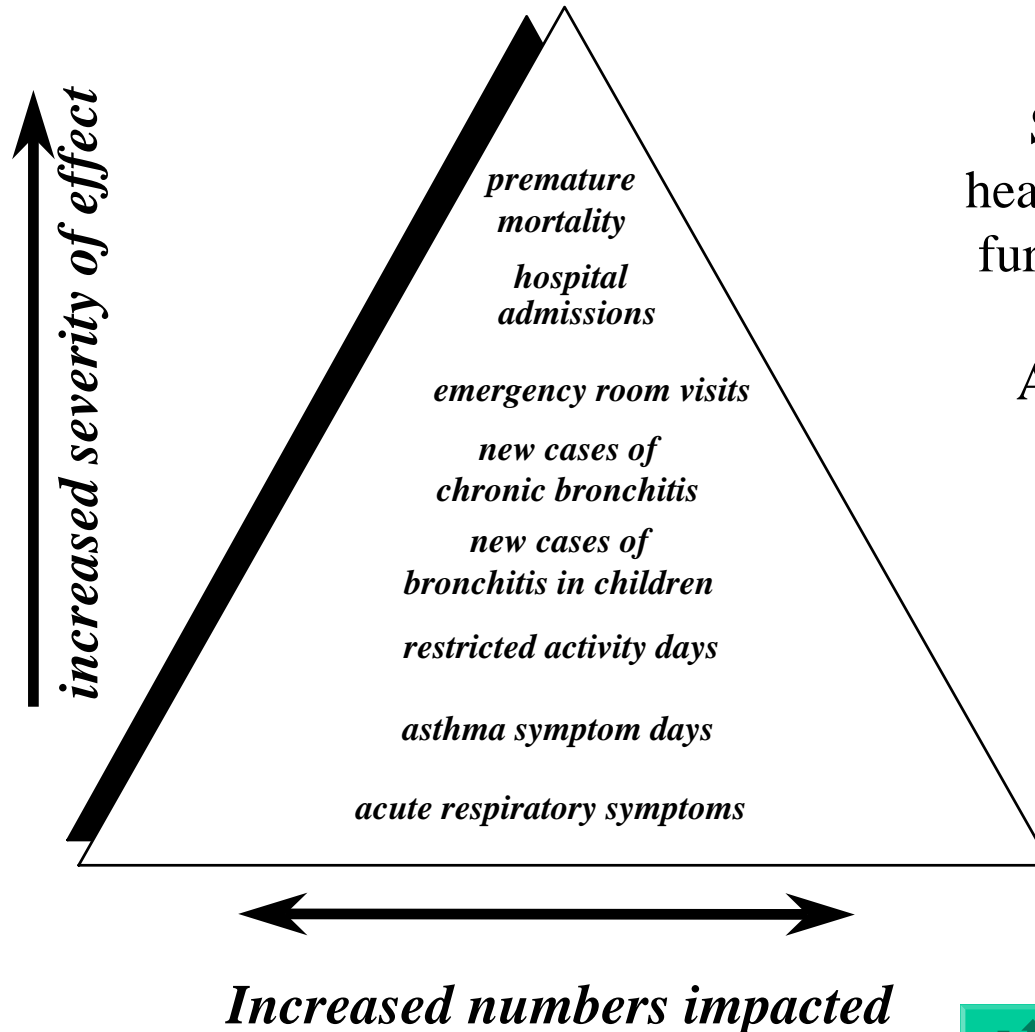


# Pollutants in AQBAT

- Outdoor concentrations of various pollutants are sampled daily at over 500 sites across Canada by the National Air Pollution Surveillance (NAPS) Programme of Environment Canada
  - source of baseline concentration data for AQBAT
- Current pollutants in AQBAT:
  - carbon monoxide (CO) (ppm)
  - nitrogen dioxide (NO<sub>2</sub>) (ppb)
  - ozone (O<sub>3</sub>) (ppb) (all year, May-Sep, Apr-Sep)
  - sulphur dioxide (SO<sub>2</sub>) (ppb)
  - fine particulate matter (PM<sub>2.5</sub>) (ug/m<sup>3</sup>) (dichot and teom)
  - particulate matter (PM<sub>10</sub>) (ug/m<sup>3</sup>) (dichot and teom)



# Health Effects Pyramid



Some of these health endpoints are further categorized into several AQBAT health endpoints

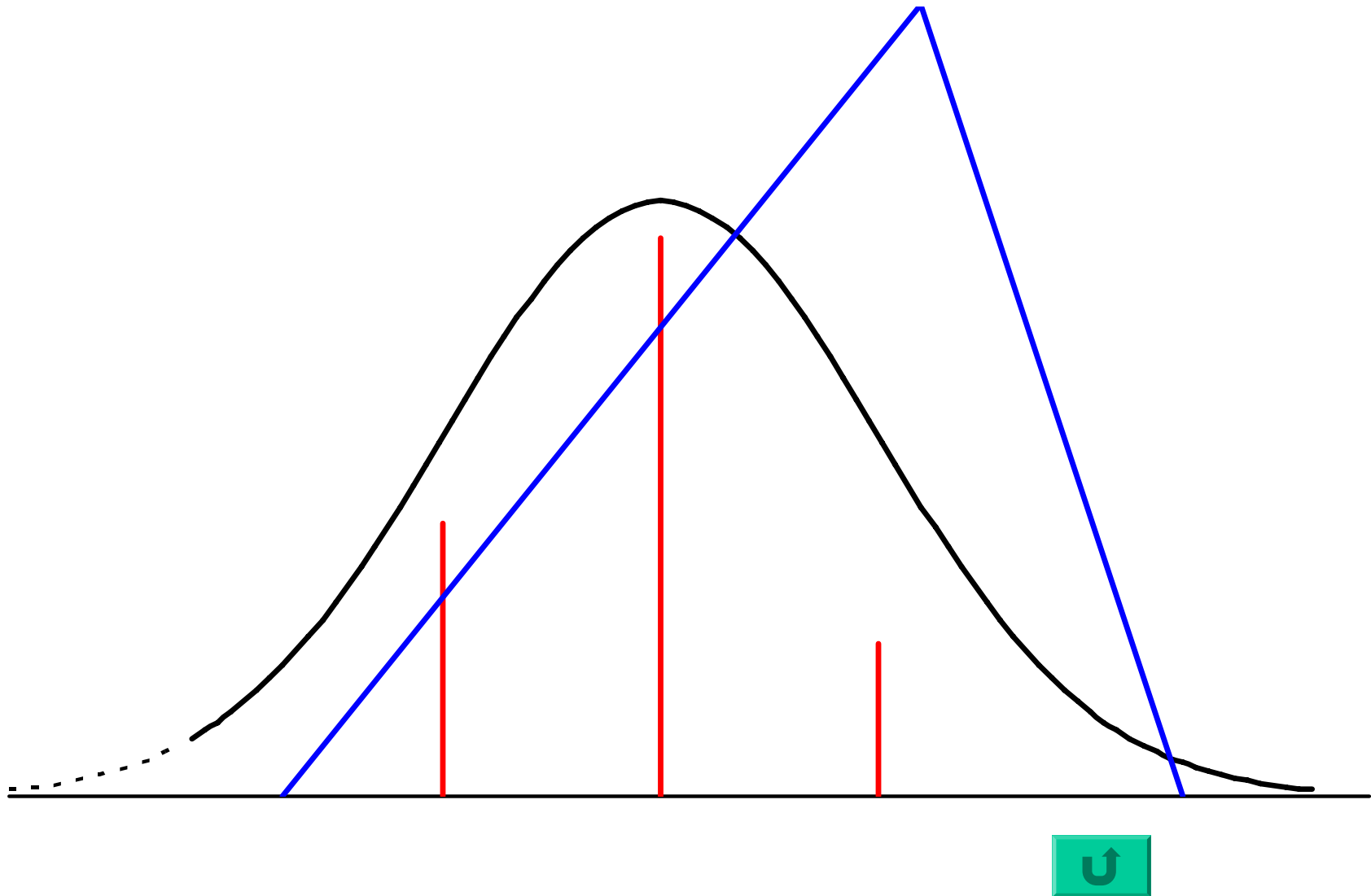


# Geographic Areas in AQBAT

- based on geography and population information from the 2001 Statistics Canada Census
- 5 Geographic Area Types:
  1. National (Canada)
  2. Provinces/Territories (13)
  3. Census Agglomeration Areas (CAs)  
**towns with 10,000+ population (140)**
  4. Census Metropolitan Areas (CMAs)  
**cities with 100,000+ population (27)**  
**CMAs are CAs**
  5. Census Divisions (CDs)  
**partition Canada (288)**  
**vary widely in size and population**



**Distribution types currently available in AQBAT**  
**Normal, Triangular and 3-point Discrete**

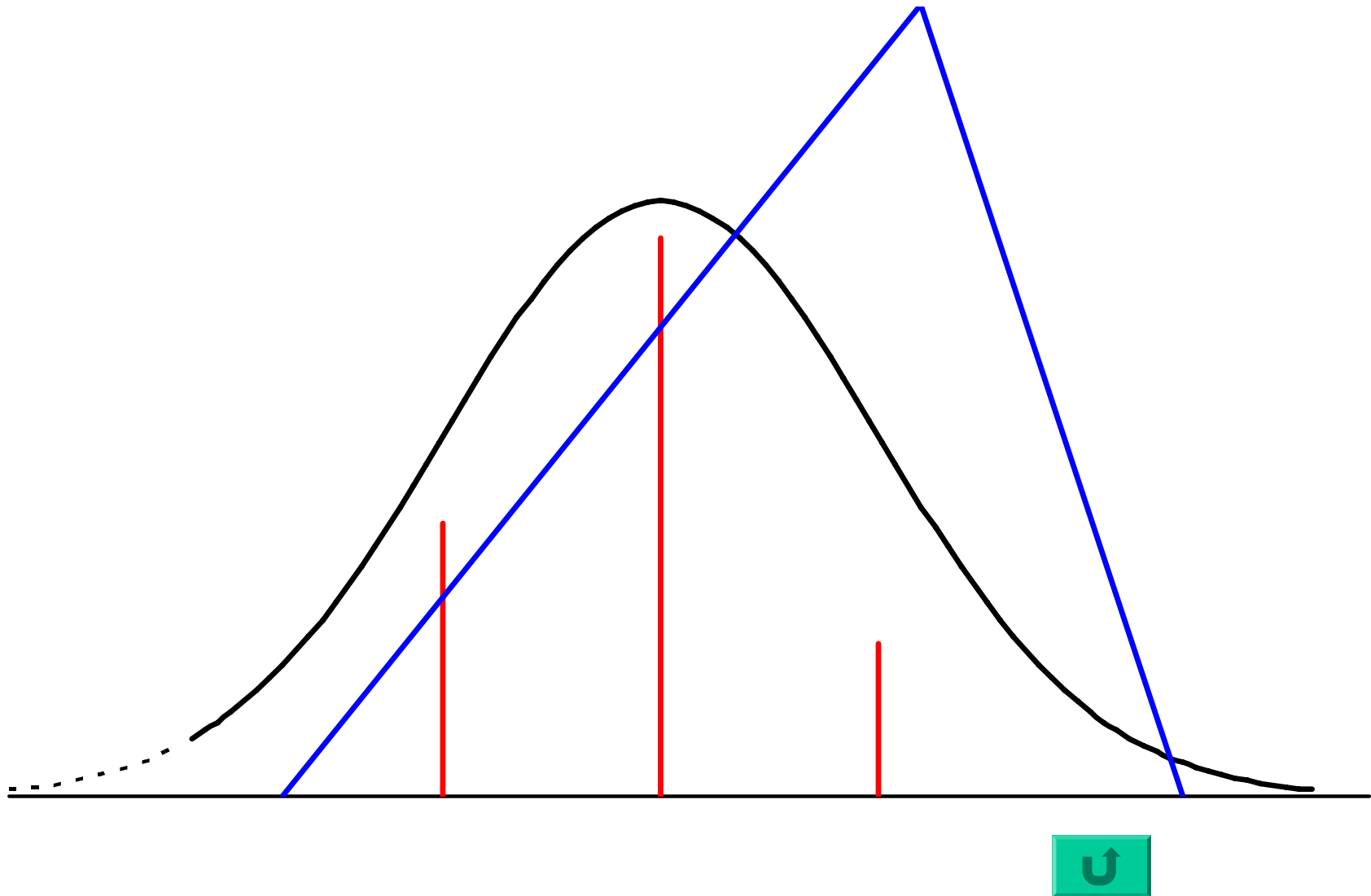


# Valuing Health Outcomes

Outcome	<u>Central</u> Estimate/Incident (C\$)	Type
Mortality	\$4,000,000	WTP
Adult chronic respiratory disease	\$256,000	WTP
Respiratory hospital admission	\$6,500	WTP & COI
Cardiac hospital admission	\$8,300	WTP & COI
Emergency room visit/asthma	\$560	WTP & COI
Child lower respiratory disease	\$310	WTP & COI
Asthma symptom day	\$44	WTP
Restricted activity day	\$71	WTP & COI
Acute respiratory symptom day	\$14	WTP



**Distribution types currently available in AQBAT**  
**Normal, Triangular and 3-point Discrete**



**Scenario Definition** [X]

[About](#) | [Scenario So Far](#) | [Baseline](#) | [Scenario Years](#) | [Check Concentration Data](#) | [Define Concentration Changes](#) | [CRF](#) | [EPV](#) | [Outputs and Summarizing](#)

**Pollutant:**  
 PM2.5 team (ug/m3)

**Concentration change type:**  
 forecast

**Apply to**

National     
  All Provinces/Territories     
  All CMAs  
 All CAs     
  All CDs     
  All geo areas  
 List built with Help Geo or last stored geo list

[Clear for Choices above the Line](#)  
[Clear All CCs](#)

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**Averaging period**

1 hour  
 8 hour  
 24 hour

[Help Geo](#)

[Retrieve](#)

**Concentration distribution is:**  
 proportionately reduced

**Reduction type:**  
 absolute

**For statistic:**  
 95%

**Reduce:**  
 only above the 50%ile concentration     
 barrier at 50%

**Annual changes relative to baseline year(s) are:**  
 pivoted

**Pivot year:**  
 2015

**Last forecast year for change:**  
 2045

Annual interpolation/extrapolation

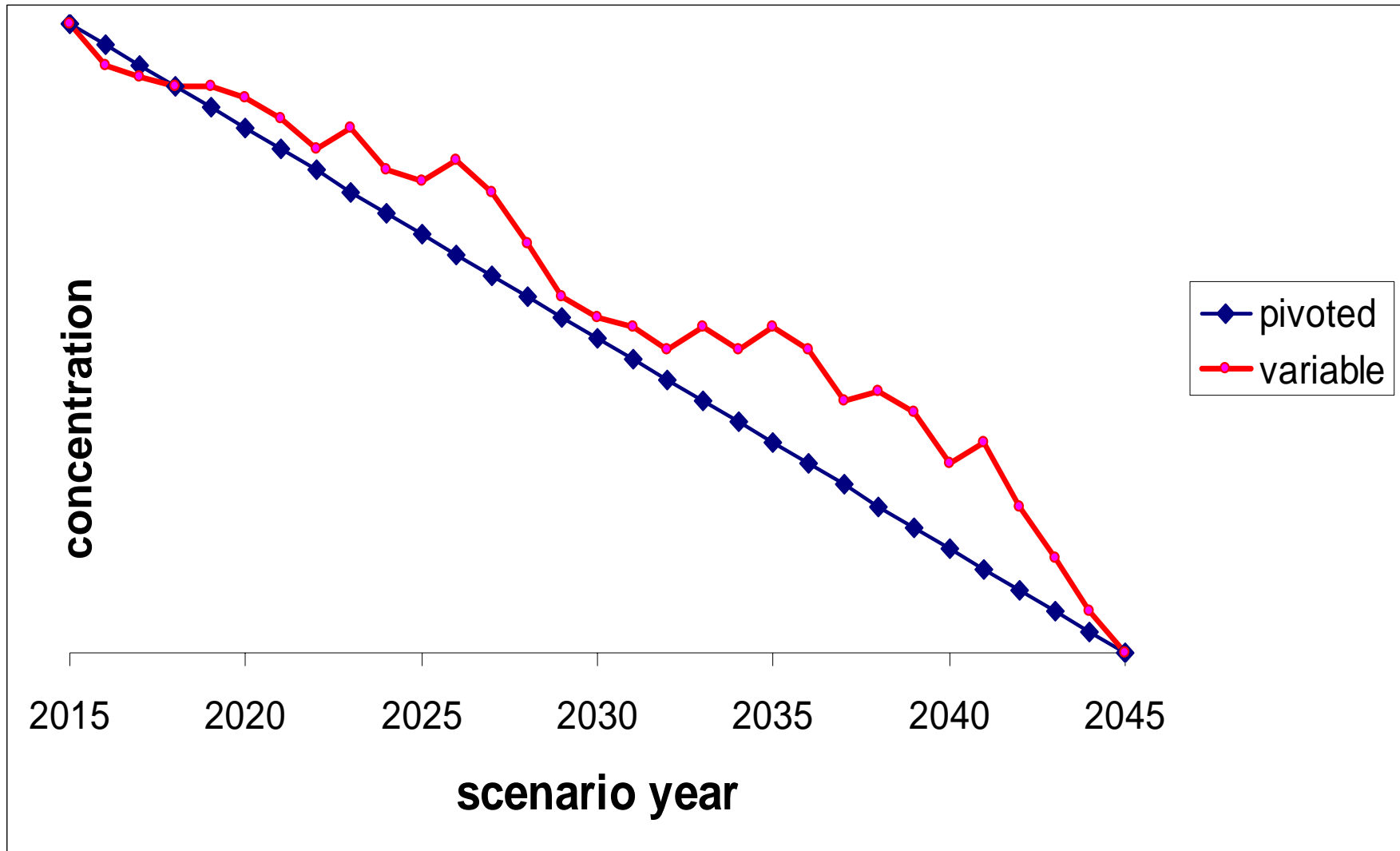
[Edit Changes](#)

[?](#)   
[Run Simulation](#)   
[View Outputs](#)   
[Save Inputs and Outputs](#)   
[S](#)   
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Annual change type



# Annual concentration change type example



**Concentration Response Function** x

DB O3 (ppb) and Acute Exposure Mortality (1 of 1) ?

Source:

**Averaging period**

1 hour

8 hour

24 hour

**Regression type**

Poisson

Poisson log

Linear

Linear log

**Beta form:**

▼

**mean**

**SE**

**n/a**

**n/a**

**n/a**

**Truncate at 0**

CRF is netted

Specify baseline rate here rather than DB as events per year per million specified population

**Threshold concentration:**

**Apply to**

National       All Provinces/Territories       All CMAs

All CAs       All CDs       List built with Help Geo or last stored geo list

Source:



Burnett RT, Stieb D, Brook JR, Cakmak S, Dales R, Raizenne M, Vincent R, Dann T. Associations between short-term changes in nitrogen dioxide and mortality in Canadian cities. Arch Environ Health. 2004 May;59(5):228-36. - result from model with 4 gases provided by 1st author, additional to published results.

Burnett et al. (2004) reported on an analysis of air pollution and mortality in 12 Canadian cities. The author provided results from additional multi-pollutant models not reported in the paper; the 4-gas model was selected based on the overall t-value among the candidate models. Percent excess mortality (associated with the mean pollutant concentration) from Poisson regression models for CO, NO<sub>2</sub>, O<sub>3</sub> and SO<sub>2</sub> respectively were: 0.19% (T = 0.73, 1.0 ppm), 1.69% (T = 3.00, 22.4 ppb), 2.60% (T = 6.16, 30.6 ppb), and 0.23% (T = 2.09, 5.0 ppb). These results translate into regression coefficients (standard errors) of: CO, 0.00190 (0.00260), NO<sub>2</sub>, 0.000748 (0.000249), O<sub>3</sub>, 0.000839 (0.000136), and SO<sub>2</sub>, 0.000459 (0.000220). Although this multi-pollutant model excluded particulate matter, it was selected as the model which best reflected the impact of the overall air pollution mix. Because of multi-collinearity among pollutants, this model should nonetheless still reflect impacts of particulate matter. In any case, the effects of particulate matter in this study were reduced substantially when modelled together with NO<sub>2</sub>, the effect of which predominated in this analysis.

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