



INTERIM METHODOLOGY

Air Pollution Model

Technical Manual

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1 Introduction

1.1 Document purpose

1. This document is the Interim Air Pollution Model Technical Manual, which provides a description of the Interim Air Pollution Model's structure and functionality, input data, and assumptions. It aims to help readers better understand and expand the model that informs the Interim Air Pollution Topic Methodology. The Model Technical Manuals aim to improve transparency and confidence in the Global Value Factors Database (GVFD), and support companies' use of the GVFD for decision-making and sensitivity analysis.
2. The Interim Air Pollution Methodology is part of a series of four interim environmental methodologies released by IFVI, as complements to the impact accounting methodologies produced by IFVI in partnership with the Value Balancing Alliance. All four methodologies are designed with similar structures and resources, outlined below.
3. For general implementation and understanding of the Interim Methodologies, the following primary resources should be utilized:
 - a. **Global Value Factors Database:** An Excel file compilation of all value factors of all methodologies. Companies should use the outputs shown here in estimating their impact values.
 - b. **Methodologies:** These documents describe the methodology of each environmental impact topic, including key assumptions and conceptual underpinnings and the data requirements of entities in using them.
4. These resources are underpinned by supplemental resources, including the following:
 - a. **Models:** Excel files for each methodology. All calculations that form the output value factors for each impact topic can be viewed and understood in detail here.
 - b. **Technical Manuals:** These documents provide a high-level description of the structure and functionality of each environmental impact valuation model.
 - c. **Central Input Data Workbook:** Upon request, users can access a single Excel file of input data that links the models across all methodologies through PowerQuery.
5. These supplemental resources are provided for three main reasons:

- a. *Transparency*: along with the methodology documents for each model, the models are made available so each step in the calculation pathway can be examined by interested users.
 - b. *Sensitivity analysis or bespoke analysis for decision making*: if users want to understand the sensitivity of the value factors to different parameters or data points in the models, then having the full models allows for this. If more geographically specific analysis of impacts under different scenarios is required for business decision making, then the models can be used as a basis for this.
 - c. *Creation of value factors for additional decision-making contexts*: value factors for all countries are provided in the GVFD but if users want to produce additional value factors for particular decision-making purposes, such as for more granular geographic locations, then the models and technical manuals are provided to allow this.
6. Review of the models and technical manuals should be done in coordination with the other resources available to ensure thorough understanding of the contents.

1.2 Model input data versus impact driver measurements

7. A distinction should be made between impact driver measurements of an entity (i.e. kg of each air pollutant) and input data used to create the value factors of the methodology. Companies using the GVFD and the Interim Air Pollution Methodology will need impact driver measurements (i.e. kg of each pollutant which they are responsible for using or converting), whereas the input data used in the GVFD is contained within the Model (the full list of input data is outlined in Appendix A). The relationship between these types of data is depicted in Figure 1.

How an entity should estimate air pollution impact:

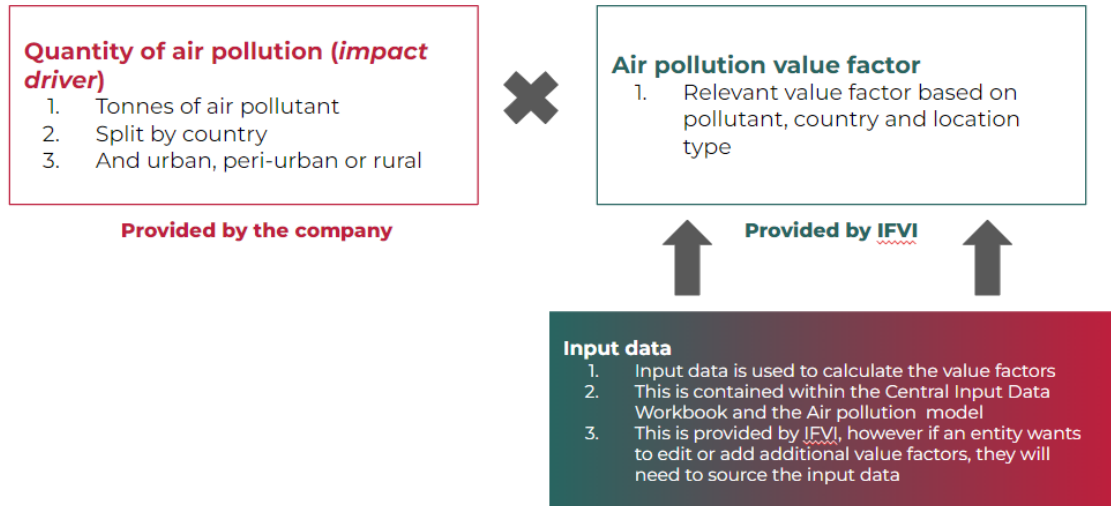


Figure 1: Difference between impact driver measurements and model input data

8. This manual focuses on model input data, rather than impact driver measurements. More detail on impact driver measurements is available in the Interim Air Pollution Methodology.

2 Model structure and functionality

2.1 High-level data architecture

9. There are three core elements to the data that informs each Interim Methodology: the Global Value Factors Database (GVFD), the models themselves, and the Central Input Data Workbook (CIDW). The models and the GVFD are both publicly available, while the Central Input Data Workbook is available upon request.
10. The Central Input Data Workbook is a central repository for all the input data sources used in all the models including the links to the sources, units and year. It also contains all key assumptions and parameters used in the models. Given the complexity of the data architecture and the importance of consistent and comparable applications of impact accounting this workbook is only available upon request.
11. The individual models then combine the relevant input data sources and calculate the value factors for each country and impact area.
12. The final value factors are then collated in the Global Value Factors Database. For most users looking to use the value factors to value environmental impacts, this will be the most important resource and can be used independently of the models and CIDW.

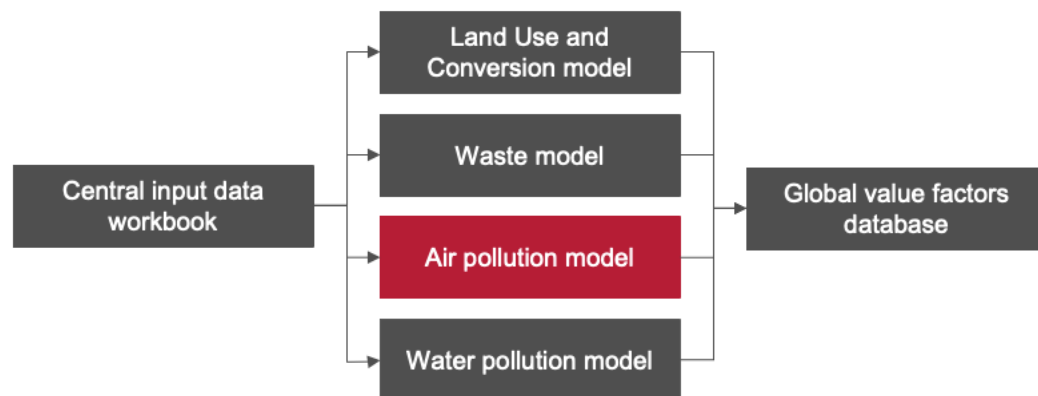


Figure 2: High-level diagram of the model architecture

2.2 Understanding and opening the Model

13. Each model contains a cover sheet that provides an overview of each tab and the appropriate way to navigate them.
14. The Model is organized, and color coded to indicate which sheets represent data inputs, calculations, or value factors. Any updates or changes to the underlying data within the

Model should be applied to the data inputs, which will then be carried through the calculation sheets to produce updated value factors.

15. Any modifications to these models may produce distinct value factors distinct from those produced by IFVI and should not be considered endorsed or approved by or a representation of the IFVI methodology.
16. When opening the Excel model for the first time, a banner may appear signifying the file is in protected view. Select 'Enable editing.' A 'Security Warning' banner may then appear as the file has external data connections. Select 'Enable Content.'

2.3 Model structure

17. The Interim Air Pollution Model is structured through three modules and seven supporting sheets:
 - a. **Value Factors** displays the final value factors for the impact of Air Pollution
 - b. **Module 1** calculates primary pollutant health impacts.
 - c. **Module 2** calculates secondary pollutant health impacts, visibility and agriculture impacts.
 - d. **Module 3** combines NO_x impacts from primary and secondary pollutant impact calculations
 - e. **Supporting sheets:** Several sheets are used for supporting data storage and calculation.
18. The main model calculations for each module are colored in dark green. Any supplementary model data/information are shown in the gray and lighter blue color. All input data tabs are colored in light red.

Value Factors

19. This section is comprised of one sheet that displays the final value factors for the Interim Air Pollution Model.
 - a. **Sheet: Air Pollution Value Factors**
This sheet provides the final value factors for the impact of air pollution. The value factors as presented are the same values in the Global Value Factors

Database, but if a user adjusts the data in the Model they may change and should not be considered endorsed or approved by or a representation of the IFVI methodology.

Module 1: Primary Health Impacts

20. The primary health module structure is shown in Figure 3 below.

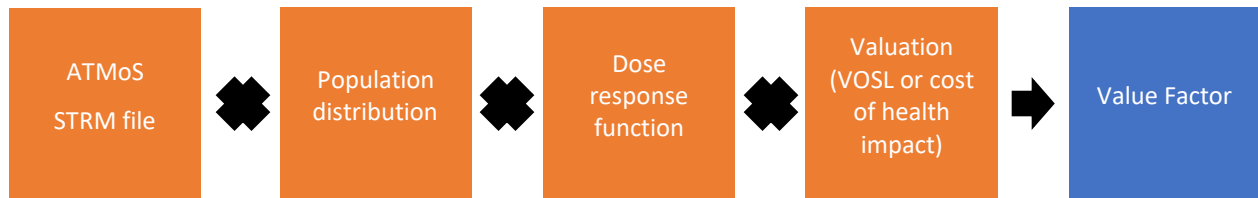


Figure 3: Module 1 structure

21. **Module 1** is comprised of seven sheets, which along with input data and other supporting sheets, calculate the primary health impact value factors:

a. **Sheet: 1a. STRM Processing**

This sheet consists of the macros to read and extract the ATMoS output files. The first macro is "Module1.SelectFolder" which allows the user to select the folder where the ATMoS outputs have been saved. The next macro "PrintSubFolders" reads the folders structure, note this must be named as "LOCATIONCODE_COUNTRY_CITY" (e.g. AUS_Australia_Canberra). The final macros is "RUNAirPolMatrixCalcs" which runs the matrix multiplication of the ATMoS output matrices and the emissions source vectors (see worksheet "Source vector"). These macro buttons have been removed for the external version of the Model, as they require ATMoS files to properly run.

b. **Sheet: 1b. Pollution Dispersion Matrices**

Contains the interim results of the macro. Each row represents one SRTM file (for a city / pollutant combination) multiplied by one pollutant source vector.

c. **Sheet: 1c. Grid Population Distribution**

Creates a gridded population distribution for each city, based on city type and country level inputs. The resulting grids are found in 1d. Custom population editor and 1e. Population grid output.

d. **Sheet: 1d. Custom Population Editor**

This sheet shows the population distribution for each country, for an urban and rural type, in a visual manner, and through the population editor contains the potential to create custom population grids for cities where the population density is well understood.

e. **Sheet: 1e. Population Grid Output**

This sheet contains automatically generated population grids for each city separated by urban and rural city type. If a custom population grid was created in module 1.d, it will be used here instead of the urban grid.

f. **Sheet: 1f. Primary Health Impacts**

This sheet calculates the primary health impacts from air pollution. It takes the pollutant dispersion matrices (produced earlier by the macro), and overlays (multiplies) this with the population grid to estimate the number of people affected. This is then multiplied by effect/capita values for different pollutants to calculate the final primary health impact per pollutant.

g. **Sheet: 1g. Primary Health VFs**

This sheet pulls out country-level primary health impact coefficients. For transport, a weighted average of urban and rural transport city level coefficients is taken. Morbidity and Mortality impacts are then aggregated for city types and pollutants. Extreme values are addressed by population distribution statistics and data gaps are removed by regional averages.

Module 2: Secondary Health, Visibility and Agricultural Impacts

22. The secondary health, visibility and agriculture module structure is shown in Figure 4.

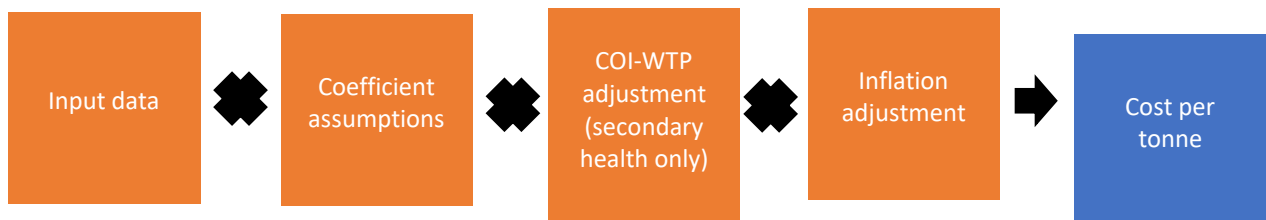


Figure 4: Module 2 structure

23. Secondary health, visibility and agriculture impacts are calculated in sub-module sections within a single sheet. Input data — a different combination of variables 1-6 for each impact — are applied to coefficient assumptions calculated from data provided by

Muller and Mendleson (2007)¹. It multiplies the outcome of these calculations and applies an inflator to produce a cost per metric ton of pollutant in 2023 USD\$. The secondary health impact calculation has an additional step applied alongside the inflator where the social costs from the Muller and Mendleson paper are adjusted from a cost of illness measurement (COI) to a willingness to pay measurement (WTP). This is done to align with the approach used in the primary health module (Module 1).

24. **Module 2** is comprised of three sheets, which along with input data and other supporting sheets, calculate a combined social cost per metric ton of pollutant. This cost is inclusive of the secondary health, visibility and agricultural impacts:

a. **Sheet: 2a. Secondary Assumptions**

This sheet contains the constants used through the module. The constants can be grouped in terms of the regression coefficients and the cost of illness to willingness to pay ratio.

b. **Sheet: 2b. Secondary Impacts**

This sheet calculates the secondary health, visibility and agricultural impacts from air pollution. Each sub-module takes input data, a combination of variables 1-6, and applies coefficient assumptions. It also calculates a coefficient. It multiplies the outcome of these calculations and applies an inflator in order to produce a cost per metric ton of pollutant.

c. **Sheet: 2c. Secondary VFs**

This sheet uses a regional average approach to fill gaps in secondary pollutant health impacts, visibility and agriculture impacts. Where a regional average approach is not possible, income-based averages are calculated as a secondary approach to fill data gaps. To avoid over-weighting US coefficients within the North American region, US State data has been removed from regional and income-based average calculations. There are no gaps in US State coefficients, however, they are included in the final summary table at the end of this sheet to provide a complete table of coefficients.

Module 3: output value factors

a. **Sheet: 3a. NOx VFs**

¹ Muller and Mendleson (2007)

This module consists of one sheet which sums the primary and secondary pollutant health associated with NO_x.

25. There are six supporting calculations sheets within the Model, these contain:

- a. **Sheet: Air Pollution General Data:** This sheet refers to general data at the country level relevant to the Interim Air Pollution Model.
- b. **Sheet: Assumptions and Parameters:** This sheet details basic assumptions and parameters used throughout the Interim Air Pollution Model.
- c. **Sheet: i. Population Data Processing:** This sheet prepares country population data for model calculations.
- d. **Sheet: ii. Emissions Grids Setup:** This sheet prepares pollution emission grids. These grids represent how pollutants are emitted in different environments and are later multiplied with the SRTM files to give final pollutant distributions.

3 Adapting the Models for Bespoke Analysis

3.1 Updates to input data, assumptions, and parameters

26. The intent of the impact accounting methodology is to provide consistent and comparable impact accounting methodologies that can be applied across entities. As such, the methodologies are intended to be used as is. IFVI will update the input data variables, assumptions, and parameters as necessary and on a regular basis, without the need for model users to make their own updates.
27. However, if any sensitivity or bespoke analysis is desired, the input data can be updated in the models.
28. Should an entity wish to add new countries, regions or geographical areas specifically to the Interim Air Pollution Model, this can be done by amending the Air Pollution General Data Sheet and the Central Inputs Data Workbook.
29. There are 66 different input data points that make up the variables in the Model. Data will need to be gathered for all variables for each country, region or geographical area to be added.
30. The ATMOs model may need to be run in order to generate additional VFs related to human health.
31. A full list of the data points are listed in Appendix A.
32. Some data inputs to the models apply across multiple models or may only exist in the Central Input Data Workbook. For users wishing to conduct bespoke analysis across multiple models with consistent and efficient data, this can be done by making adjustments to the underlying Central Input Data Workbook. This workbook and a set of models that are directly linked to it via PowerQuery are available upon request.

Appendix A: Full List of Input Data

Data point	Unit
Population	Number
Population density	People / miles ²
Rural population	%
GNI PPP per capita	2021 international dollars
GNI PPP per capita relative to USA	2021 GNI PPP index relative to USD
GNI PPP	2021 international dollars
Land area	Km ²
Urban land area	Km ²
Population concentration	% of people in cities over 1 million
Urbanization	% living in cities
Median income	2022 USD\$
Mortality	Deaths per 1000
Oxygen	PPM
Average high temperature	Fahrenheit
Annual rainfall	Inches
Capital city population	Number
Rural land	Km ²
Urban population split	%
Rural population split	%
City population density	People / km ²

Bibliography

Muller N.Z. and Mendelssohn, R., (2007). Measuring the Damages of Air Pollution in the United States. *Journal of Environmental Economics and Management*, Vol. 54 (1), pp. 1-14.

Please note: this bibliography only refers to sources referenced in this user guide. For a bibliography that includes the theoretical and empirical basis of the Methodology, please refer to the separate methodology document.