



Quick Start Guide

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Contents

Introduction.....	3
Getting Started with BenMAP-CE.....	6
Step 1: Add a New Setup.....	10
Step 2: Load Data into BenMAP-CE.....	10
Selecting your shapefile	10
Defining Your Pollutants.....	11
Monitor Data.....	14
Incidence Data.....	15
Population Data.....	16
Health Impact Functions.....	17
Valuation Functions.....	19
Step 3: Create Air Quality Grids	21
Step 4: Estimate Health Impacts.....	22
Step 5. Aggregate and Pool Incidence Results	24
Step 6. Estimating Economic Values.....	27
Step 7. Generate Reports	28
Generate Tabular Reports from Configuration Results (.CFGRX)	28
Generate Tabular Reports from Aggregation, Pooling and Valuation (.APVRX)	28
Generate Audit Trail Reports.....	29
Appendix A. Health Impact Function Editor	30
Frequently Asked Questions about BenMAP-CE.....	32

Introduction

I. What is Air Pollution Benefits Analysis, and How Can BenMAP-CE Help?

Air pollution benefits analysis is the art and science of applying findings from the epidemiological and economics literature to estimate the health impacts and economic value of air pollution changes. The environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE) software simplifies this practice by applying the algorithms and data that users need to calculate the quantity and dollar value of premature deaths and illnesses associated with changes in air pollution. For example, the program includes a subset of air quality monitoring data, recent and projected demographic and baseline health data, concentration-response relationships drawn from the published epidemiological literature, and economic value estimates based on the published economics literature. Linking these data together in this way allows users to more easily answer an array of policy questions (see Highlight Box 1).

Figure 1 is a conceptual overview of how information in the epidemiological literature provides the data needed to create the health impact functions BenMAP-CE uses to calculate the incidence of health outcomes.

Before you begin using the BenMAP-CE software and following the Quick Start Guide, give some thought to the attributes of the community, region or nation where you wish to perform benefits assessment—including the types and levels of air pollutants, the demographic profile of the population, the health effect(s) of interest to you, and the associated economic value of those health effects. If you are performing your analysis in the U.S., there is an excellent chance that BenMAP-CE contains most of the data you need for your analysis. If you decide to add your own data to BenMAP-CE to carry out different types of analyses, the articles listed at the end of this section can help you think through the types of considerations you might include in selecting studies from the epidemiological and economics literature.

Highlight Box I: What Kinds of Questions Can you Answer?

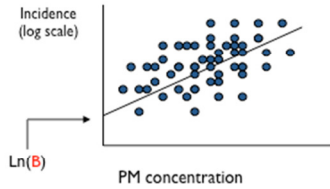
You can use BenMAP-CE to answer a variety of questions regarding air pollution exposure and risks that are relevant to your community or research interests. For instance:

- What levels of pollution are people exposed to?
 - Use BenMAP-CE to: generate maps of pollutants)
- How would health or economic benefits change with different regulatory programs?
 - Use BenMAP-CE to: compare benefits associated with regulatory programs;
- What are the health impacts and costs of current air pollution concentrations?
 - Use BenMAP-CE to: estimate health impacts and costs of existing air pollution concentrations.
- What would be the health benefits of alternative ambient air quality standards?
 - Use BenMAP to: estimate health impacts and costs of existing air pollution concentrations.
 - Use BenMAP-CE to: perform sensitivity analyses of health or valuation functions, or of other inputs

Figure 1: Use of Epidemiological Literature to Calculate Incidence of Health Outcomes with BenMAP-CE

The air pollution epidemiology literature provides the risk coefficient, or beta, that is an input to the health impact function...

Epidemiology Study



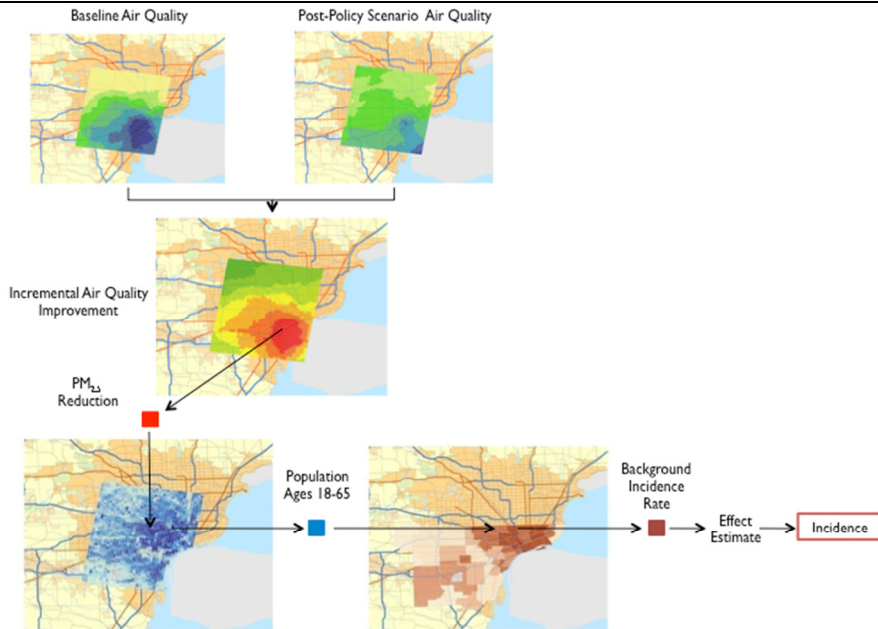
$$\ln(y) = \ln(B) + \beta(\text{PM})$$

Health impact function

$$\Delta Y = Y_0 (1 - e^{-\beta \Delta \text{PM}}) * \text{Pop}$$

Y_0 – Baseline Incidence
 β – Effect estimate
 ΔPM – Air quality change
 Pop – Exposed population

...and BenMAP-CE uses a combination of built-in and user-provided data to calculate this health impact function



II. Quick Start Guide

The Quick Start Guide was designed to get you up and running with a basic benefits assessment. Because you may want to perform a more complicated analysis, the EPA is also working on a comprehensive and free online training guide. The examples described in this Quick Start Guide rely upon assumptions and input data that EPA has historically used in its analyses (see Highlight Box 2)—but that you should feel free to replace with your own parameters.

Highlight Box 2: Examples of How EPA and Others Have Used BenMAP

EPA and others have generally used BenMAP to answer one of two types of questions:

- What are the benefits of a new air quality policy that will be implemented in the future?
 - The [Clean Air Interstate Rule](#) analysis
 - The [Non-Road Diesel Analysis](#) (link)
- What is the burden of recent or future levels of air pollution on human health?
 - For [recent air quality levels](#)
 - For recent and future air quality levels and [according to the source of emissions](#).

The BenMAP Flow Diagram shown in Figure 2 provides an overview of a BenMAP-CE analysis. This figure illustrates the choices you will have to make regarding the modeling of population exposure, the types of health effects to model, and how to place an economic value on these health effects. Please note that BenMAP-CE does not include air quality modeling capabilities, and instead relies on externally created air quality modeling and monitoring data.

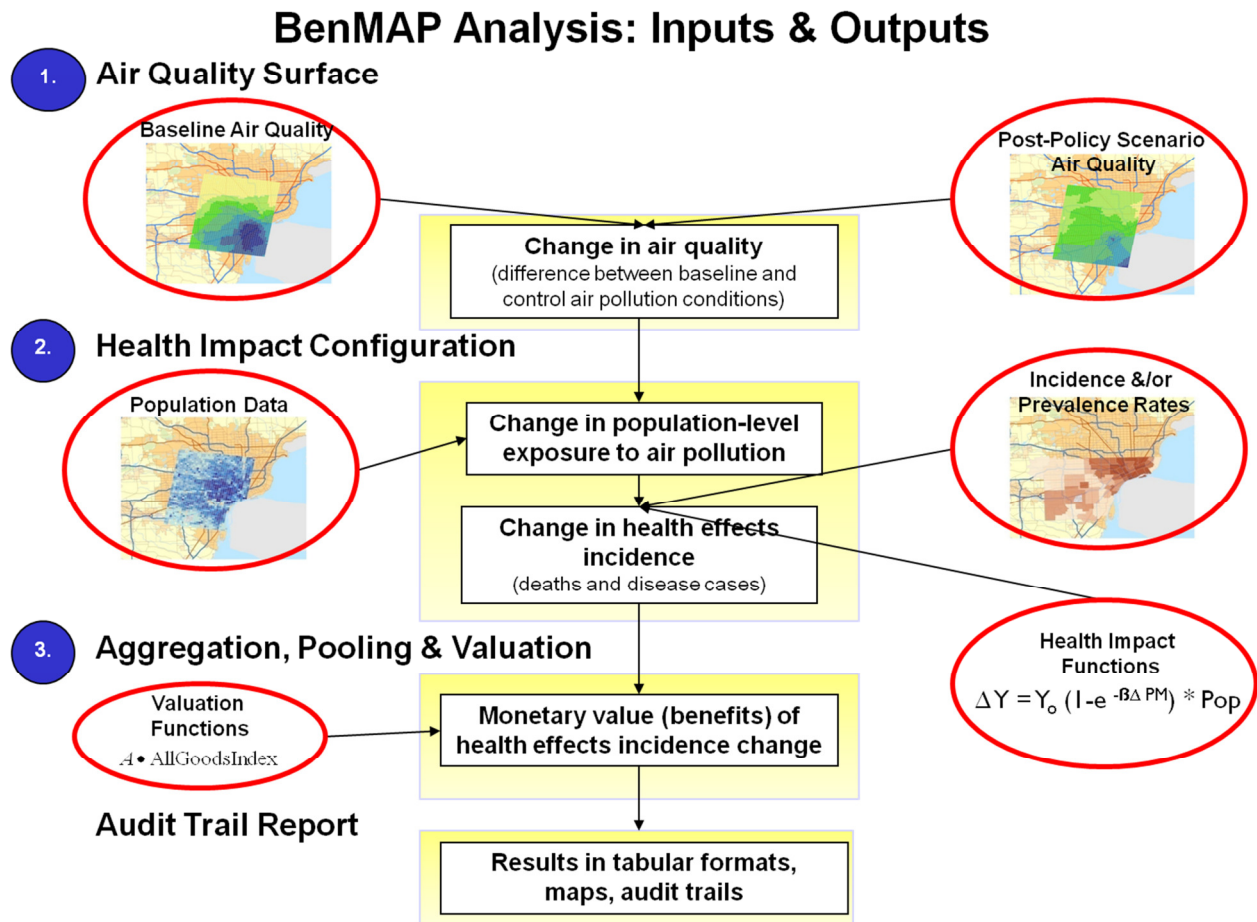
As you use this Quick Start Guide, keep in mind that the list of Frequently Asked Questions at the end may be useful in answering your questions and helping you with troubleshooting.

After you finish the Quick Start Guide, you should have a firm understanding of the datasets and data formats required by BenMAP-CE. You should also be able to run BenMAP-CE to conduct a simple benefit analyses.

Some helpful resources:

- BenMAP Legacy User's Manual (available at <http://www.epa.gov/air/benmap/docs.html>). While this manual was designed for the previous version of the program, you may still find it to be a useful reference.
- This [paper](#) by Hubbell, Fann and Levy (2009) that describes the best practices for performing a local-scale health impact assessment.
- This [article](#) by Fann, Bell, Walker and Hubbell (2012) that considers the type of data reported in epidemiological studies that would be most useful for risk assessments.
- This [article](#) by Wesson, Fann, Morris, Fox and Hubbell (2010) that considers approaches for developing city-scale air quality management plans.

Figure 2: BenMAP-CE Flow Diagram



Getting Started with BenMAP-CE

1. Installing BenMAP-CE

Before you start using this Quick Start Guide, you need BenMAP-CE installed on your computer. (The BenMAP-CE installer is available at https://benmap.rti.org/software/Software_Page.html)¹ Detailed instructions on how to install BenMAP-CE including system requirements can also be found on the website. Please note that if you have an earlier version of BenMAP-CE, you should archive any important data and uninstall before installing this software release.

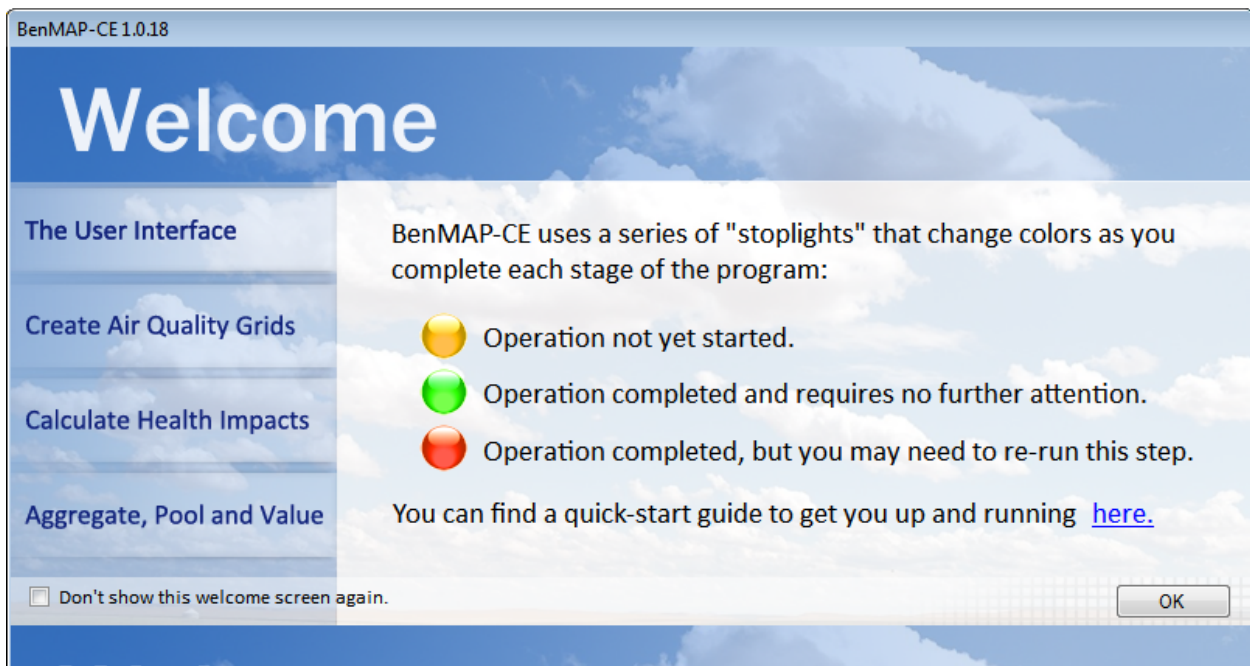
¹ Previous versions of BenMAP-CE were available at US EPA’s BenMAP website (<http://www.epa.gov/air/benmap/beta.html>). This website is currently being upgraded; once complete, this Quick Start Guide will be updated to reflect the new URL.

II. Download Quick Start Data Files

The example datasets required to complete the exercises included in this quick start guide can be downloaded from https://benmap.rti.org/data/Data_Page.html. Save these files to your computer in a folder you can easily navigate to. We recommend storing them within a folder entitled *Quick Start Data Files* within your *My Documents* directory.

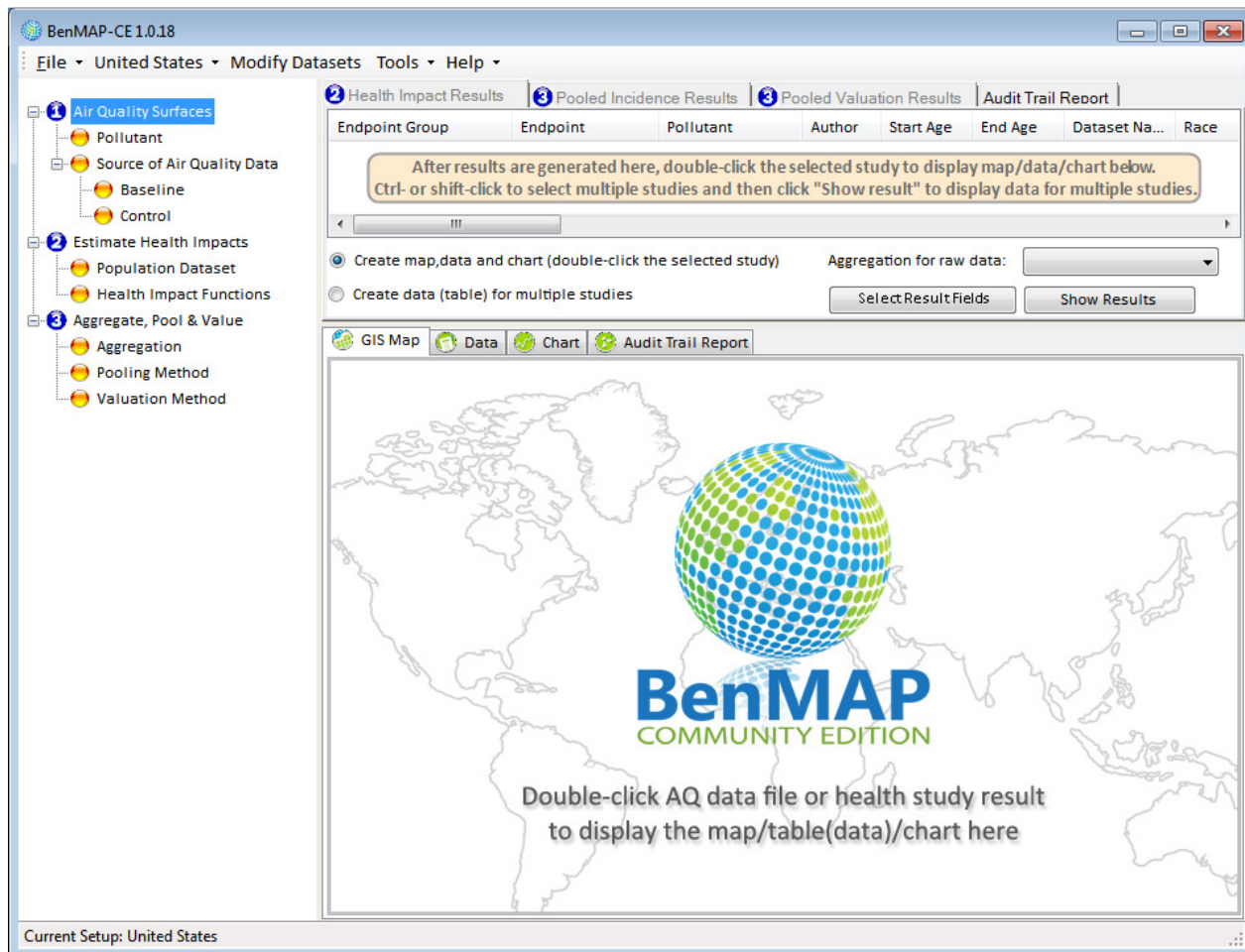
III. Opening BenMAP-CE

Once installed BenMAP-CE will open to the *Welcome* Window (shown below). The tabs on the left of the *Welcome* Window provide an overview of the processes you will use to run the Benefits Mapping and Analysis Program software. The *Welcome* Window opens to the *User Interface* tab which highlights **the stoplight metaphor in BenMAP-CE**. When first launching the program you will notice a series of yellow circles on the left-hand window pane that correspond to various program analytical steps. These circles change colors based on the status of each step. Click through each of the remaining tabs and take a quick look. We will work through each of these steps in detail in this Quick Start Guide.

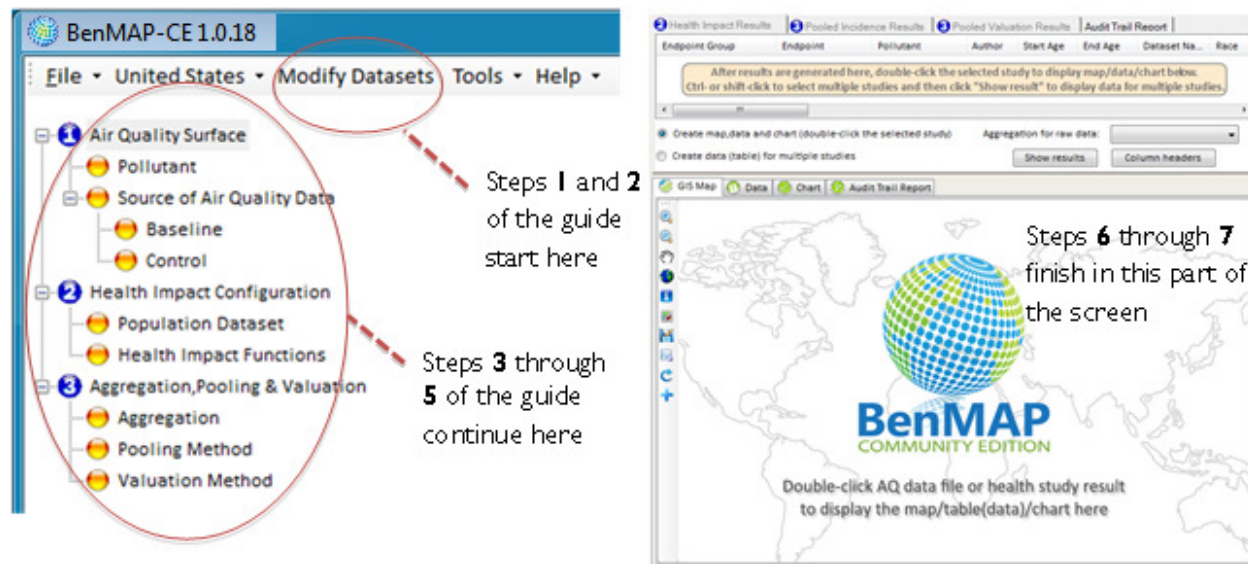


IV. The BenMAP-CE Main Window

After closing the *Welcome* Window, you will see the BenMAP-CE main screen as shown below.



As we work through the Quick Start Guide you will interact with different parts of the BenMAP-CE interface. Steps 1 and 2 entail generating a new setup and loading data into BenMAP-CE. This work happens within the *Modify Datasets* Window which is opened by clicking the *Modify Datasets* button in the upper toolbar of the main screen. Steps 3 through 5 include generating the air quality grids, calculating health impacts, and aggregating the results. These five steps will occur in the left pane of the main window and represent the core functionality of the BenMAP-CE software. Steps 6 and 7 are the final component of the process where economic value is assessed and reports are generated. This happens over in the right-hand mapping pane of the BenMAP-CE interface.



V. Saving BenMAP-CE Files

At various stages of the Quick Start Guide you will be prompted to save a BenMAP-CE project file (.projx), which will save the file names and locations of the air quality (.aqgx), configuration (.cfgx) and aggregation, pooling and valuation (.apvx) that you have selected. Note that the project file does not contain these other BenMAP-CE data, but rather records their physical location on your computer.

Step 1: Add a New Setup

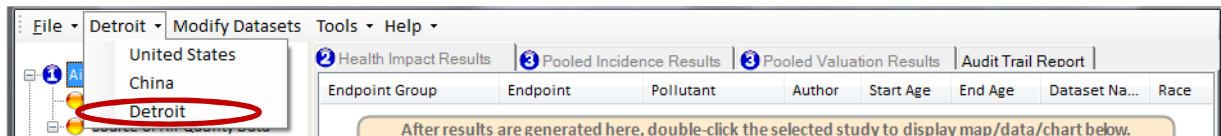
A “setup” is a collection of databases that work together when you conduct an analysis. In this Quick Start Guide, we will perform an analysis using data from the Detroit, Michigan metropolitan area:


- Start BenMAP-CE
- Click *Modify Datasets* at the top left. This will bring up the *Modify Datasets* window.
- Click the *Add* button next to the *Available Setups* box.
- Type *Detroit* into the *New Setup Name* box in the *New Setup* window and click the *OK* button.
- Confirm that *Detroit* is listed in the *New Available Setup Name* drop down menu and all other windows in the *Modify Datasets* window are blank when *Detroit* is selected.
- Click the *OK* button at the bottom right to close the *Modify Datasets* window.

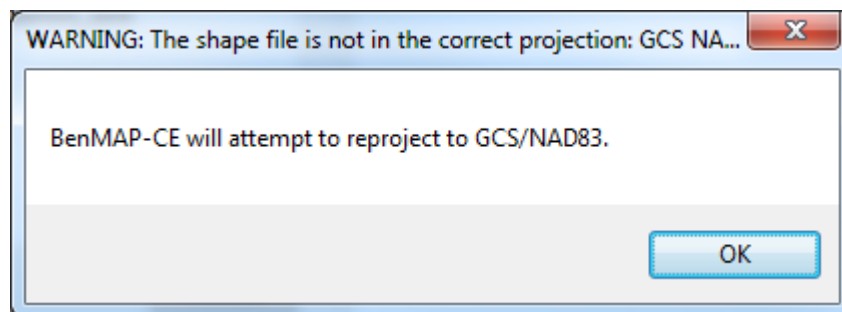
Step 2: Load Data into BenMAP-CE

Selecting your shapefile: BenMAP-CE uses [shapefiles](#) to define the geographic area in which the program will allocate air quality data, calculate health impacts and aggregate results.

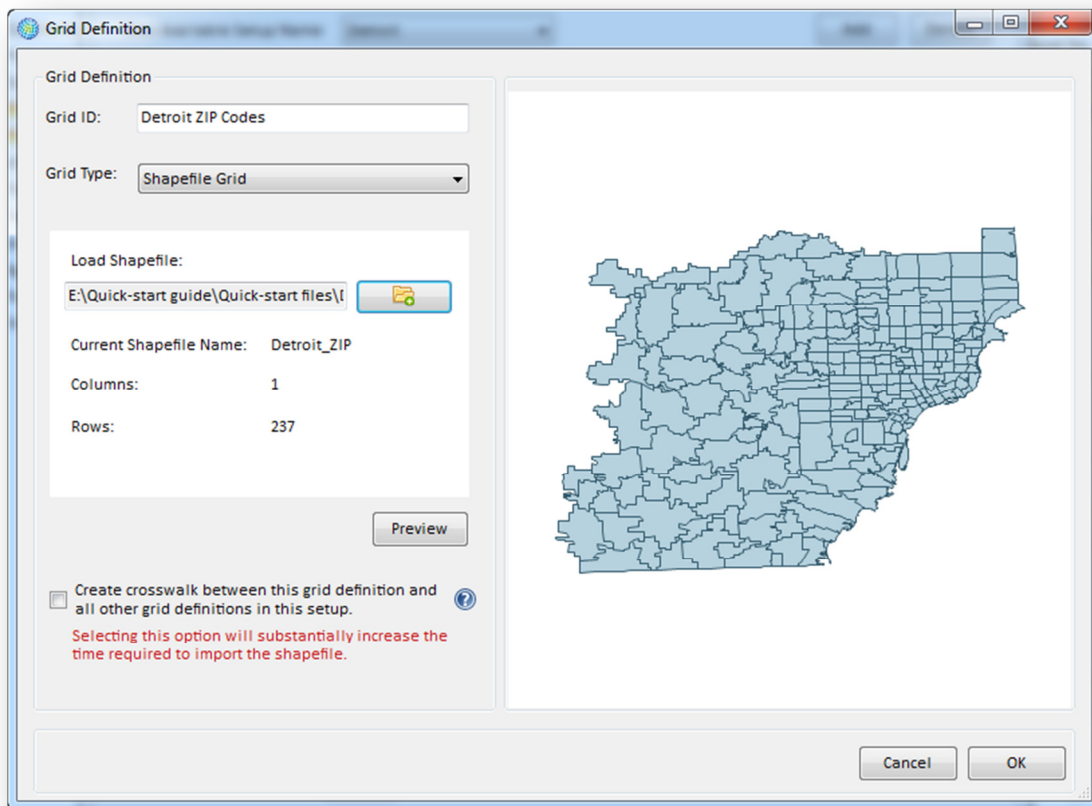
- Make sure you have BenMAP-CE open and that *Detroit* is listed as the active setup. You can confirm this by ensuring that *Detroit* is listed next to *File* in the menu bar.



- Select *Modify Datasets* and click the *Manage* button under the *Grid Definitions* box. This will bring up the *Manage Grid Definitions* window.
- Click the *Add* button, which will bring up the *Grid Definition* window.
- In the *Grid ID* box, type *Detroit ZIP Codes*. This will be the name of one of the three new Grid Definitions you are going to add.
- Select the open folder icon , and open the “Detroit_ZIP.shp” file in the Quick start data files.
- If your shapefile isn’t in the correct projection, BenMAP-CE will need to reproject it and the following *Warning Message* may appear. Click *OK* and wait for the reprojection to complete.



- Confirm that the Detroit ZIP codes map correctly in the preview window. Your screen should now look like this:



- Click the *OK* button to return to the *Manage Grid Definitions* window.
- Using the same steps as above, add *Detroit_1km* and *Detroit Counties* shapefiles and give them the Grid ID *Detroit 1km* and *Detroit Counties* respectively.
- When you are done, click the *OK* button to return to the *Modify Datasets* window and the three Grid IDs should appear in the *Grid Definitions* box.

Defining Your Pollutants: In this step you are specifying the key attributes of the pollutant for which you will later estimate health impacts; these characteristics include the time period over which the pollutant is measured or modeled. While BenMAP-CE can estimate health impacts for conceivably any pollutant, here we focus on fine particulate matter or PM_{2.5}.

Define a pollutant

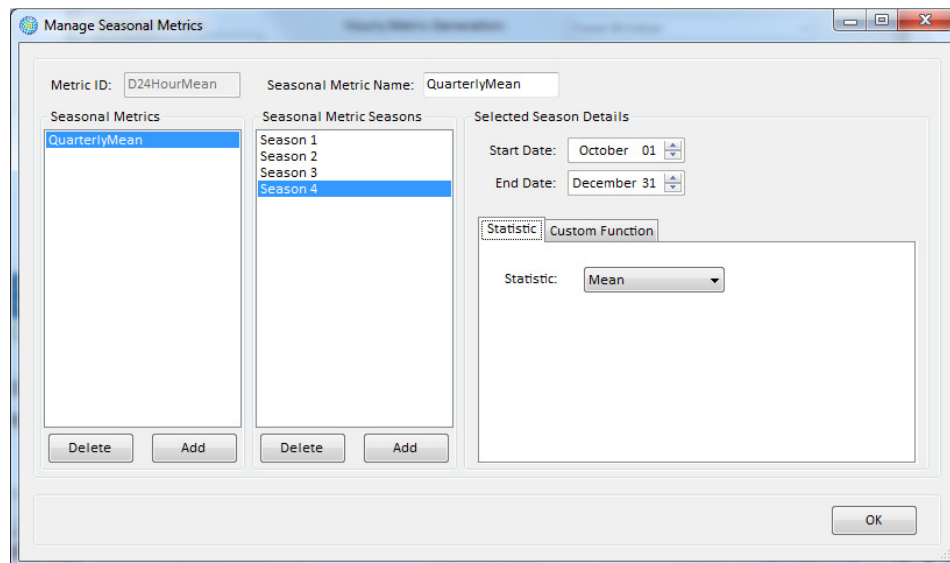
- In the *Modify Datasets* window, click the *Manage* button under the *Pollutants* box. This will bring up the *Manage Pollutants* window.
- Click the *Add* button under the *Available Pollutants* box. This will bring up the *Pollutant Definition* window.
- In the *Pollutant ID* box, type *PM2.5*. This will be the name of the new pollutant. (Note: It is very important to spell the name of the pollutant correctly, as this name will serve as a unique ID that the program links to Health Impact functions, Model Data, etc.).

Define metrics for a pollutant: Observation Type

- Select *Daily* as the *Observation Type* in the drop down menu.
- Click the *Add* button under the *Metrics* box. You will see *Metric 0* shown in the *Metrics* box. Click in the *Metric Name* box and change the name from *Metric 0* to *D24HourMean*. Here you are telling BenMAP-CE that PM2.5 is a pollutant averaged across 24 hours in each day. If we were to specify a pollutant that was averaged over part of the day (e.g. ozone), then you would change *Hourly Metric* from *Fixed Window* to *Moving Window*. For more on metrics, you can refer to section 4.1.2 of the [BenMAP Legacy User's Manual](#).

Define metrics for a pollutant: Seasonal Metric

- Click the *Edit* button under the *Seasonal Metrics* box. This will bring up the *Manage Seasonal Metrics* window.
- Click the *Add* button under the *Seasonal Metrics* box. This will add a Seasonal Metric to the Metric named *Seasonal Metric 0*. Rename this Seasonal Metric by clicking in the *Seasonal Metric Name* box where it says *Seasonal Metric 0* and typing *QuarterlyMean*.
- Click the *Add* button under the *Seasonal Metric Seasons* list within the *Manage Seasonal Metrics* Window. For *Season 1* set the *End Date* to March 31. To change the date, highlight either the month or the day and use the up and down arrows to increase or decrease the highlighted value.
- Click the *Add* button under the *Seasonal Metric Seasons* list within the *Manage Seasonal Metrics* Window. Note that the *Start Date* value is automatically set to one day after the previous seasons *End Date* value. For *Season 2* set the *End Date* to June 30.
- Click the *Add* button under the *Seasonal Metric Seasons* list within the *Manage Seasonal Metrics* Window. For *Season 3* set the *End Date* to September 30.
- Click the *Add* button under the *Seasonal Metric Seasons* list within the *Manage Seasonal Metrics* Window one final time. There is no need to set the *End Date* for *Season 4* because it will default to December 31st.
- Your screen should now look like this:



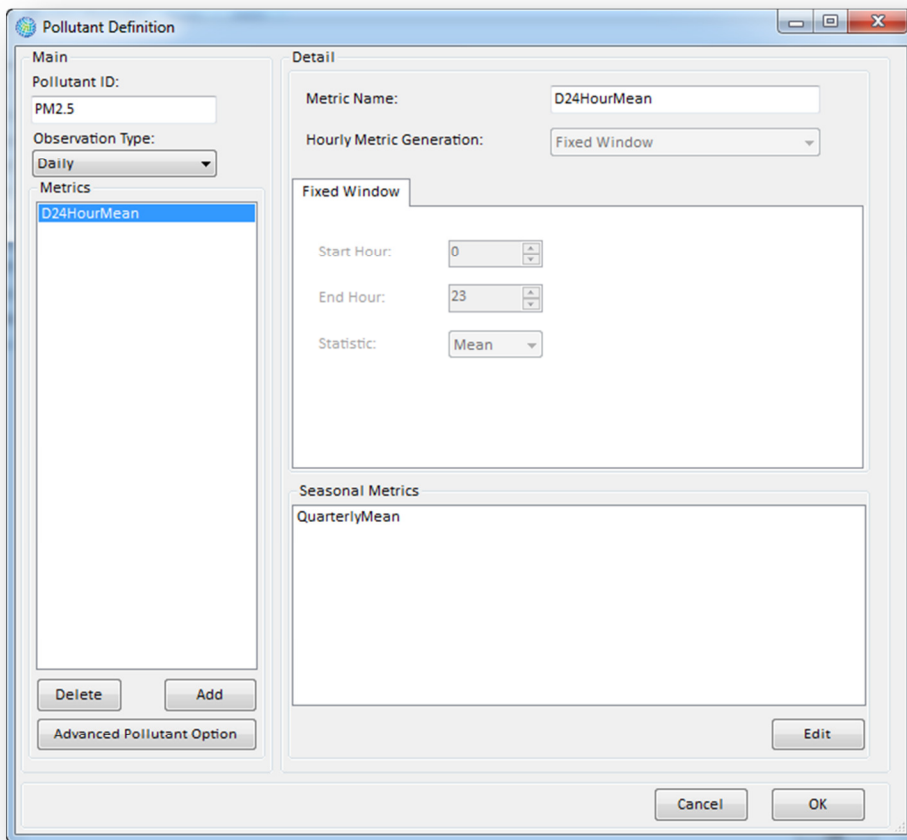
- Click *OK* to close the *Manage Seasonal Metrics* Window.
- Click the *Advanced Pollutant Options* button underneath the *Metrics* box to open the *Define*

Seasons window. This will create a new season for this Seasonal Metric – all four seasons need to be defined here as well. Change the *End Date* value for *Season 1* to *March 31*.

- Click the *Add* button under the *Seasons* list again. This will add a second season to the Seasonal Metric. Change the *End Date* value for this second season to *June 30*.
- Click the *Add* button under the *Seasons* list again, and change the *End Date* value for this third season to *September 30*. Add the 4th and final season. Click the *OK* button in the *Define Seasons* window to return to the *Manage Seasonal Metrics* window.

Then click the *OK* button in the *Manage Seasonal Metrics* window to return to the *Pollutant Definition* window. A seasonal metric tells BenMAP-CE that there is a subset of the year during which the pollutant metric should be averaged—in this case, the daily averages are then averaged within each of 4 seasons. For more on seasonal metrics, you can refer to section 4.1.2.2 of the [BenMAP Legacy User's Manual](#).

Your screen should now look like this:



- Click the *OK* button to return to the *Manage Pollutants* window.
- Click the *OK* button one final time to return to the *Modify Datasets* window. You will see *PM2.5* shown in the *Pollutants* box.

Optional: You can go through the same steps as above to add other pollutants as needed (you may find it helpful to check the pollutants defined in the United States Setup, which covers a wide range of pollutants). Note that you can use other observation types (e.g., hourly) and metrics (e.g., D1HourMax, D8HourMax, seasonal metrics).

Monitor Data: If you neither have nor use monitoring air quality data for your analysis (i.e., you only use modeling data), you can skip this step. Monitor data may be formatted as an Excel or CSV (comma-separated values) file.

Note: Air pollution data that can be used in BenMAP-CE are of two types - point source monitoring data and grid-definition-based modeling data. Whichever data you use, they must be associated with a particular pollutant that you have defined. Only the point source monitoring data are stored in the setup database. The modeling data are loaded into BenMAP-CE when you conduct the analysis.

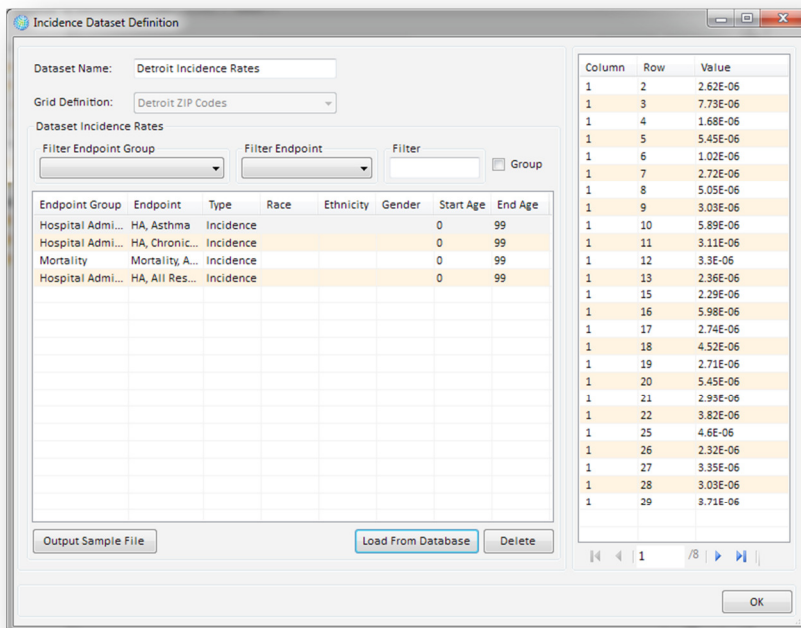
In the *Quick Start Data Files* you downloaded and saved, locate *Detroit Monitors PM25.csv* and open it in Excel or a text editor. You will see eight variables in the file: Monitor Name, Monitor Description, Latitude, Longitude, Metric, Seasonal Metric, Statistic, and Values. Four variables (i.e., Monitor Name, Latitude, Longitude and Values) are required to be filled in. The “Values” variable contains a string of comma separated values with missing values signified with a period (‘.’), with the entire string of values enclosed by quotation marks.

Now you can close the *Detroit Monitors PM25.csv* file and begin adding it to BenMAP-CE. Make sure you are in the *Modify Datasets* window and *Detroit* is selected in the *Available Setups* drop down.

- Click the *Manage* button under the *Monitor Datasets* box. This will bring up the *Manage Monitor Datasets* window.
- Click the *Add* button under the *Available Datasets* box. This will bring up the *Monitor Dataset Definition* window.
- In the *Dataset Name* box, type *Detroit PM Monitors*.
- In the *Pollutant* box (on the right hand side of the *Dataset Name* box), click the drop down arrow and select *PM2.5* (the pollutant you defined in the previous stage).
- In the *Year* box, type *2007* to indicate that your PM data are for the year 2007.
- Click *Load Data From File* and use the *Browse* button to select the *Detroit Monitors PM25.csv* file. Click *Open*.
- Click *Validate* to run validation tool. *Validating Data import* results window will open. Confirm that there were 0 errors and 0 warnings. Click *OK* to close validation results.
- Click *OK* in the “Load Monitor Dataset” window.
- Click *Yes* when prompted to “Save this file associated with PM2.5 and 2007.”
- Confirm that PM2.5 is listed in the *Dataset Contents* box.
- Click *OK* to close the *Monitor Dataset Definition* window.

- Set the Grid Definition to *Detroit ZIP Codes*.
- Click the *Load from File* button. Click the Browse button, locate the incidence dataset entitled *Detroit Incidence Rates.csv*, and click *Open*.
- Click *Validate* to run validation tool. *Validating Data import* results window will open. Confirm that there were 0 errors and 0 warnings. Click *OK* to close validation results.
- Click *OK* in “Load Incidence/Prevalence Database” window. Click *Yes* in the confirmation window that opens.

When BenMAP-CE finishes loading the data, your Incidence Dataset Definition screen should



look like the following:

- Click *OK* in the *Incidence Dataset Definition* window to return to the *Manage Incidence Datasets* window.
- Click *Ok* once more to return to the *Modify Datasets* window.

Population Data: You will be adding population data from a CSV file. First view the population dataset entitled *Detroit Population.csv* in your Quick Start Data Files (this is a large file, and may be slow to open). The BenMAP-CE database includes U.S. population data gridded to a 12km domain that covers the Continental U.S., as well as county-level population data. These data will suffice for most people—but if you are performing an analysis outside the U.S., or need more finely resolved population data, you will need to import your own data into the program.

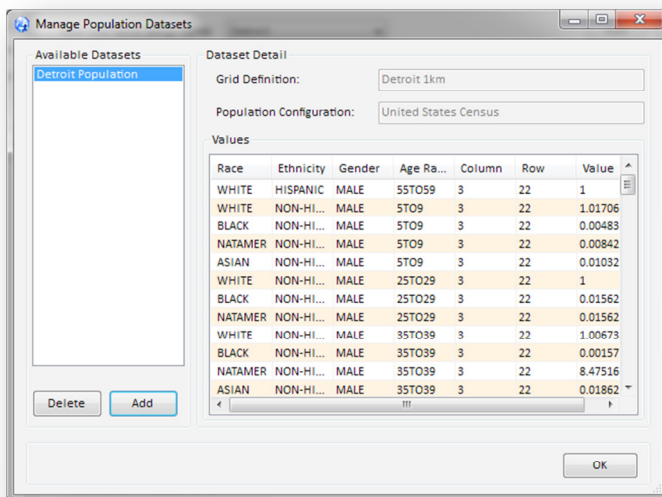
Close *Detroit Population.csv* and begin adding it to BenMAP-CE. Make sure you are in the *Modify Datasets* window and *Detroit* is selected in the *Available Setups* drop-down.

- Click the *Manage* button under the *Population Datasets* box. This will bring up the *Manage*

Population Datasets window.

- Click the *Add* button under the *Available Datasets* box. This will bring up the *Load Population Datasets* window.
- In the *Population Dataset Name* box, type *Detroit Population*. This will be the name of the new population dataset.
- In the *Grid Definition* drop-down window, select *Detroit 1km*.
- Next, you need to define the population data that you are loading into BenMAP-CE by selecting the population configuration of United States Census; this tells BenMAP-CE how the demographic characteristics of your population are categorized.
- Finally, click the *Browse* button next to the *Database* box. Select the *Detroit Population.csv* file and click *Open*.
- Click *Validate* to run validation tool. *Validating Data import* results window will open. Confirm that there were 0 errors and 0 warnings. Click *OK* to close validation results.
- Click *OK* to load the file and close the *Load Population Dataset* window. Note that this could take several minutes as BenMAP-CE loads the data.

Your *Manage Population Datasets* window should now look like the following:



- Click *OK* in the *Manage Population Datasets* window to return to the *Modify Datasets* window.

Health Impact Functions: BenMAP-CE contains a large library of health impact functions developed using risk estimates reported in peer-reviewed epidemiology studies. Here you will be adding new health impact functions from a CSV file. First view the data format using *Detroit Health Impact Functions.csv* in your Quick Start Data Files.

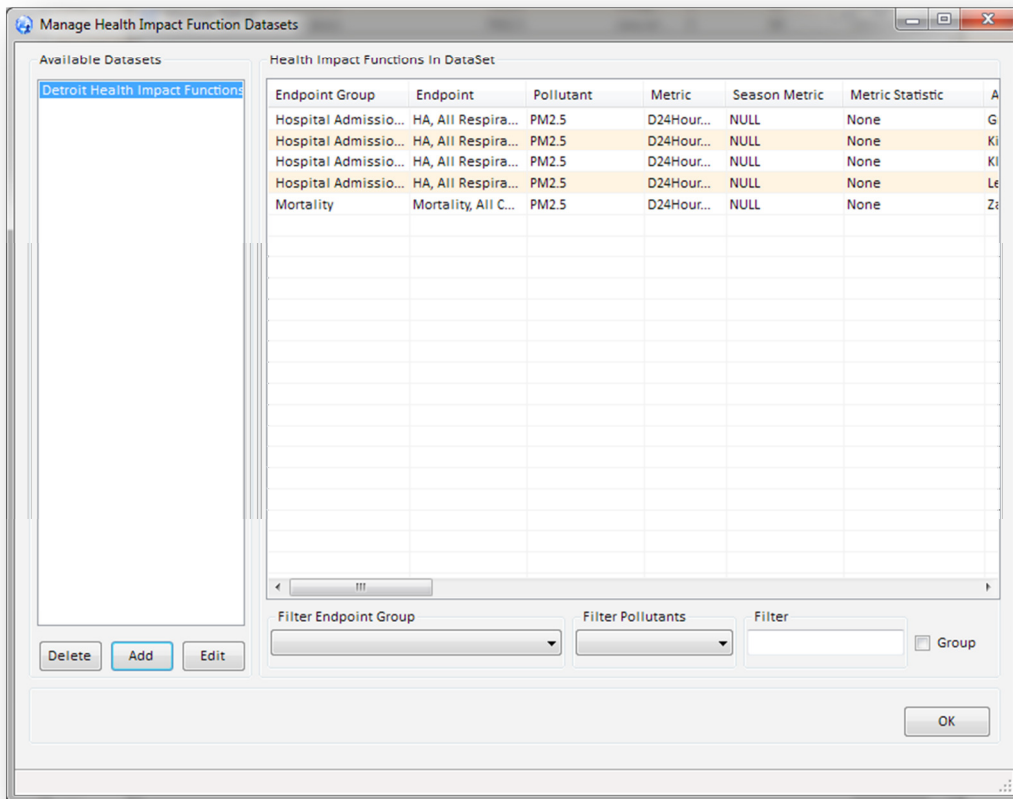
Close *Detroit Health Impact Functions.csv* and begin adding it to BenMAP-CE. Make sure you are at the *Modify Datasets* window and *Detroit* is selected in the *Available Setups* drop-down.

- Click the *Manage* button under the *Health Impact Functions* box. This will bring up the

Manage Health Impact Function Datasets window.

- Click the *Add* button under the *Available Datasets* box. This will bring up the *Health Impact Function Dataset Definition* window.
- In the *Health Impact Function Dataset Name* box, type *Detroit Health Impact Functions*. This will be the name of the new health impact function dataset.
- Click the *Load From File* button.
- Locate the *Detroit Health Impact Functions.csv* file and click *Open*.
- Click *Validate* to run validation tool. *Validating Data import* results window will open. Confirm that there were 0 errors and 0 warnings. Click *OK* to close validation results.
- Click *OK*. This will load the file.
- Click *OK* again to return to the *Manage Health Impact Function Datasets* window.
- Use the scrollbar to view the entries for individual health impact function. You can also sort columns by author, endpoint or other variables.

Your screen should now look like this:



Click the *OK* button to return to the *Modify Datasets* window.

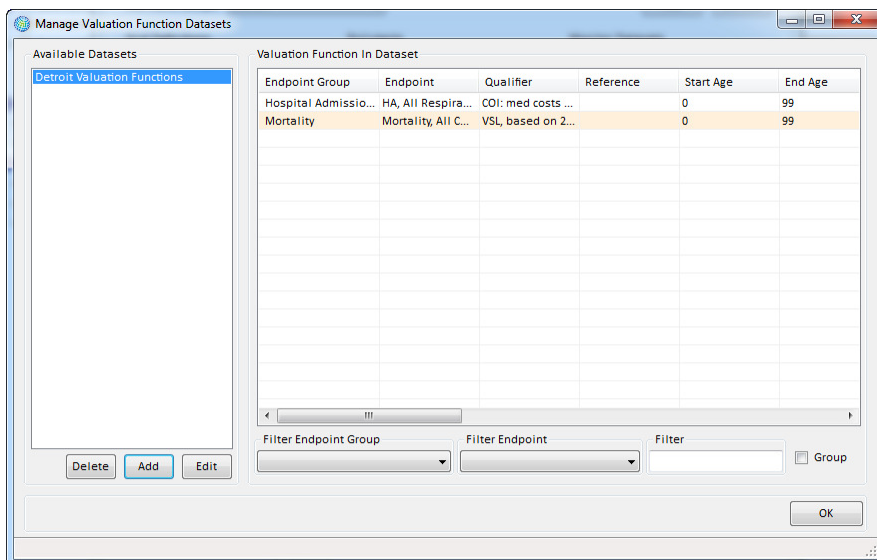
Note: If the purpose of your analysis is to generate incidence results only (i.e., you don't want to attach dollar values to the incidence results), you can go to Step 3 directly now. If you do want to estimate the economic value of the health impacts, you will need to continue adding a valuation function dataset.

Valuation Functions: BenMAP-CE contains a library of valuation functions to translate the reduction in risk of adverse health outcomes, which usually accompanies improvements in air quality, to quantifiable economic values. Valuation functions in BenMAP-CE rely on unit values for reductions in risk of a particular health effect that are reported in peer-reviewed literature. More information is available in the [BenMAP Legacy User's Manual](#) about valuation functions and important considerations for importing new data into BenMAP-CE for these analyses. Here you will be adding value functions from an Excel file. First view the data format using *Detroit Valuation Functions.csv* in your Quick Start Data Files.

Close *Detroit Valuation Functions.csv* and begin adding it to BenMAP-CE. Make sure you are at the *Modify Datasets* window and *Detroit* is selected in the *Available Setups* drop-down.

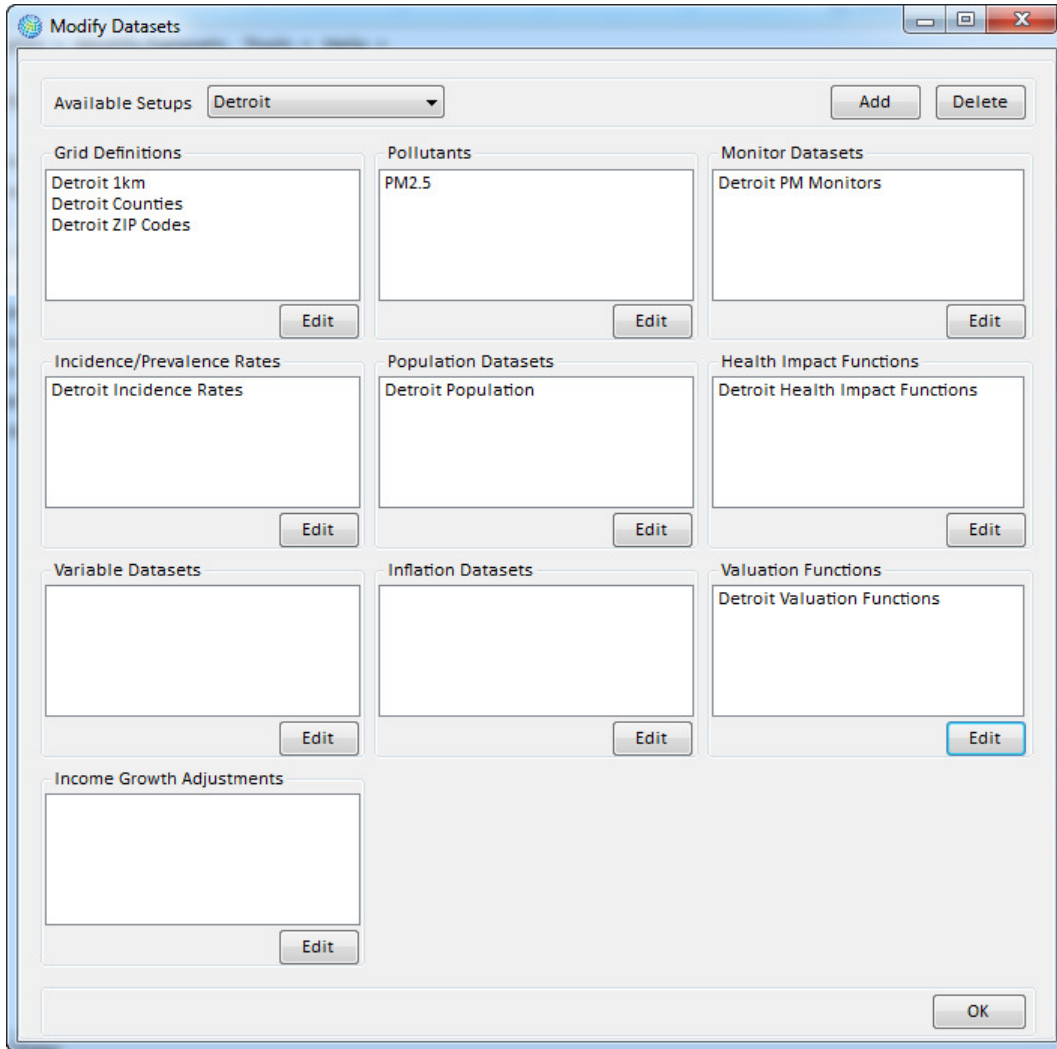
- Click the *Manage* button under the *Valuation Datasets* box in the *Modify Datasets* screen. This will bring up the *Manage Valuation Function Datasets* window.
- Click the *Add* button under the *Available Datasets* box. This will bring up the *Valuation Function Dataset Definition* window.
- In the *Valuation Function Dataset Name* box, type *Detroit Valuation Functions*. This will be the name of the new valuation function dataset.
- Click the *Load From File* button, locate the *Detroit Valuation Functions.csv* file, and click *Open*.
- Click *Validate* to run validation tool. *Validating Data import* results window will open. Confirm that there were 0 errors and 0 warnings. Click *OK* to close validation results.
- Click *OK* to load the file
- Click *OK* again to return to the *Manage Valuation Function Datasets* window.

Your screen should now look like this:



- Click the *OK* button to return to the *Modify Datasets* window.

Congratulations! You have completed adding all datasets you will need for this training course. Your screen should look like this:




Click the *OK* button at the bottom of the *Modify Datasets* window to return to BenMAP-CE main window. You can now conduct BenMAP-CE analyses.

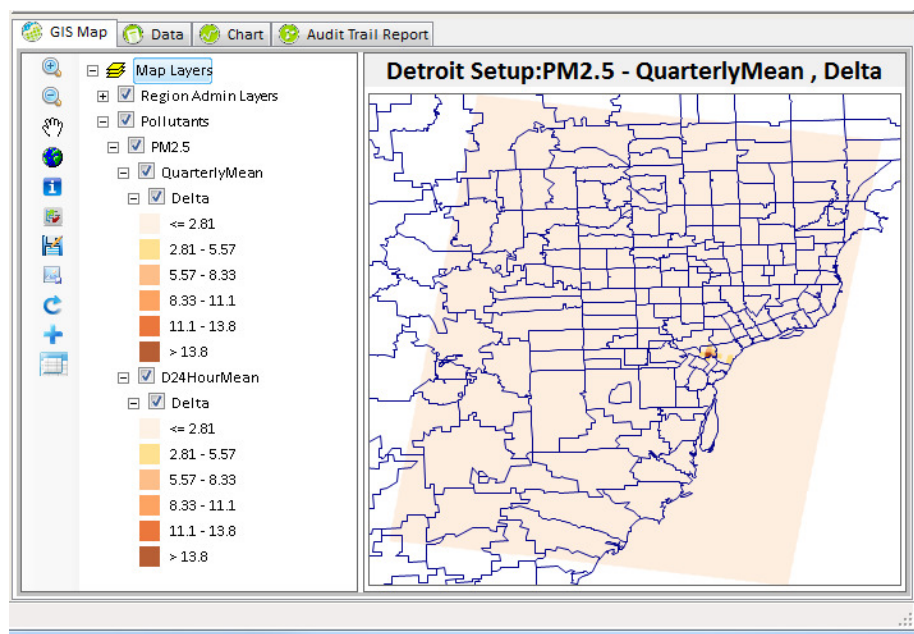
Step 3: Create Air Quality Grids



BenMAP-CE estimates health impacts with user-supplied air quality data; the program is not an air quality model. BenMAP-CE provides three options for creating air quality grids: Model Direct, Monitor Direct, and Monitor Rollback. Here you will be inputting Detroit PM_{2.5} air quality modeling data and using the Model Direct method to generate a baseline air quality grid and a control-scenario air quality grid.

Open *Detroit Baseline.csv* to view the format of modeling air quality data. Now close *Detroit Baseline.csv* and begin using it to create an air quality grid.

- Start BenMAP-CE. Click the drop-down menu next to the *File* menu and select *Detroit* (the default value is *United States*). Verify that the *Current Setup* listed in the status bar at the bottom of the window now says *Detroit*.
- Double-click *Pollutant* to open the selection window. Click, hold and drag the PM_{2.5} pollutant from the left-hand window to the right-hand window. Click *OK*.
- Next, Double-click *Baseline*. Make sure that the *Grid Type* is set to *Detroit 1km* and that *Model Data* is selected. Click *Next*.
- Click the open folder icon  and select the *Detroit Baseline.csv* file in your Quick Start Data Files. Click *Validate* and confirm there were no errors with file. Click *OK*.
- In the *Save As* window, give the baseline air quality grid a name: *Detroit Baseline*.
- Repeat the steps above, this time creating a control air quality grid using the *Detroit Control.csv* file and saving the new air quality grid with the name *Detroit Control*.
- Double-click *Air quality data (baseline-control)* to display an air quality map in the *BenMAP-CE GIS* window. Verify that the check box next to *Delta* in the *D24HourMean* layer is selected to view the difference between the baseline and control PM_{2.5} levels in each grid cell.

Your screen should look something like this (colors may vary):



- Determine the air quality change in one of the grid cells by using the *Identify* tool . This will bring up the *Identify* window.
- Save the .shp file by selecting the *Save shapefile* button .

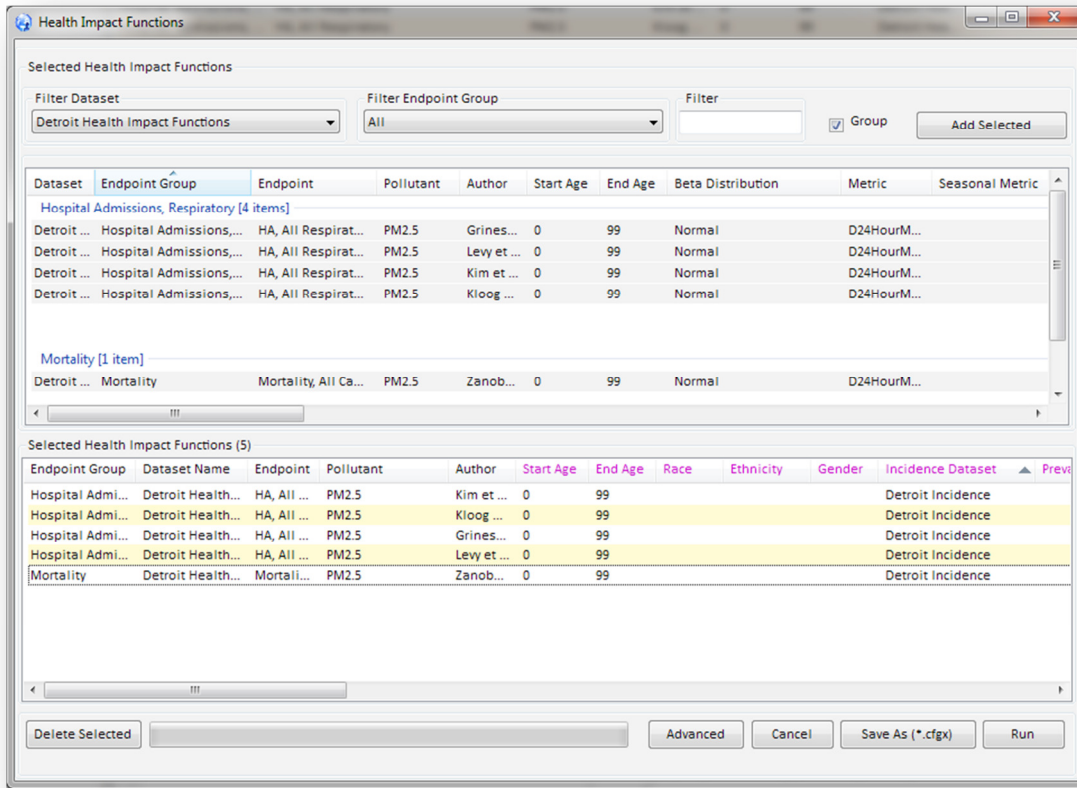
Note: If the purpose of your analysis is to examine air quality data only, you are done! You can then save the maps you generated and create an audit trail report for your analysis (Go to Step 7 to generate an audit trail report). For most BenMAP-CE users, however, the goal may be to estimate health benefits and/or value them. If so, go to the next step now.

Step 4: Estimate Health Impacts

To estimate health benefits, you will need to create and run a BenMAP-CE configuration file (*.cfgx). A configuration is a reusable file that specifies the air quality grids, health impact functions, population data, and other parameters necessary for an analysis. The results obtained from running a configuration are the estimated health impacts associated within each air quality grid cell for a given scenario. In this Detroit example, we are estimating the number of avoided health impacts associated with an air quality management plan. Here you will create a configuration for an analysis of the effect of PM_{2.5} on premature deaths and respiratory hospital admissions.

- Make sure *Detroit* is selected in the drop down next to *file* in the BenMAP-CE main window.
- Double-click the *Population Dataset* button, where you will find that the *Population Dataset* is preconfigured to *Detroit Population* and the *Population Year* is set to *2010*. Click *OK*.
- Next, double-click *Health Impact Functions*. Click inside the top window and hold down the “Ctrl” and “A” button to highlight all of the health impact functions. Click hold and drag these functions to the bottom window. Or, drag them from the top to bottom window one-by-one.

Your screen should now look like this (there should be a total of five functions in your *Selected Health Impact Functions* panel):



- Click the *Run* button.
- When prompted to Run and save the CFG results file, click *Yes*. Save the file as *Detroit configuration results*.
- When BenMAP-CE finishes generating results, you will be returned to the BenMAP-CE main window.

Note: Using the CFGRX file you just created, you could now go to Step 7 to generate tabular reports to show the endpoint-specific health benefits due to air pollution reduction if:

- You don't want to pool your incidence results --- for many of the health endpoints (e.g., mortality), BenMAP-CE contains several different health impact functions from different studies that you could choose to include in your configuration. Pooling refers to combining the results of two or more health impact functions into single results.
- You don't want to monetize the health benefits.

If you would like to conduct either of the above two analyses, go to the next step now.

Step 5. Aggregate and Pool Incidence Results

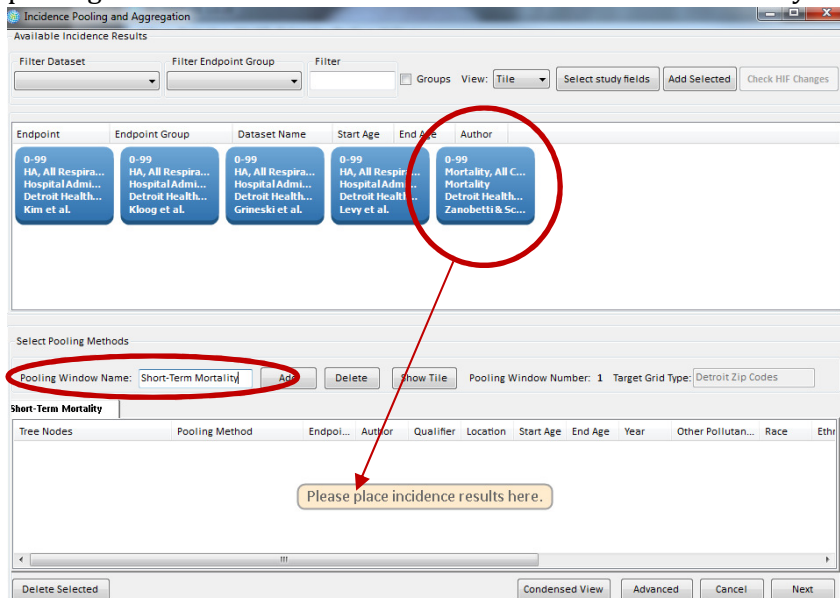
In this step, you will create a file that aggregates, pools, and values (APV) your health impact estimates; this file will save your preferences, and can generally be used for other analyses. Aggregating refers to the process of summing values from a smaller to a larger space—for example, from 1km grid cells to counties. Pooling (a type of quantitative meta-analysis) is the practice of combining the results of two or more health impact functions into a single result. Finally, valuing incidence estimates is the process of applying economic values to incidence results to get monetized benefits (You will value impacts in Step 6).

To create an APVX file, BenMAP-CE works by first aggregating results to the level that you have specified. It then pools the aggregated incidence results. Finally it values the aggregated and pooled incidence. Here you will change the aggregation level from the 1km grid-level to the county level, and then generate a single estimate of outpatient visits for individuals of all ages by pooling two health impact functions.

Aggregate Results from the 1km to the County Level. Double-click the *Aggregation* button and aggregate the incidence and valuation results to the *Detroit Counties* level. Click *OK*.

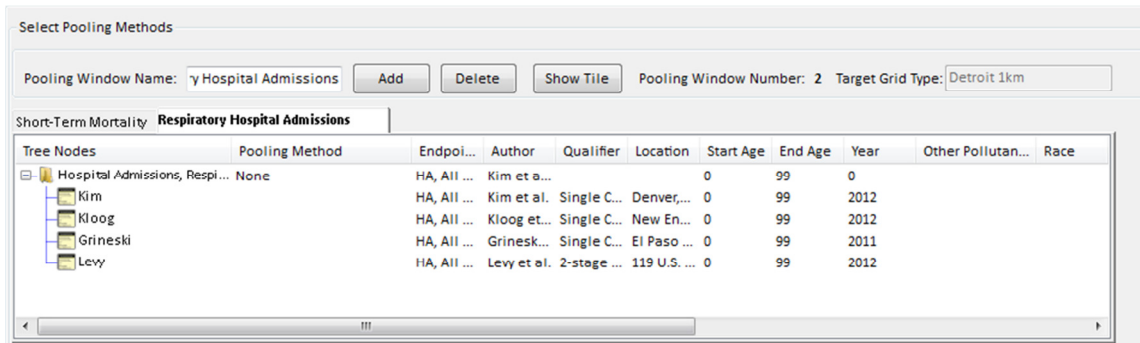
Pool results. Double-click the *Pooling Method* button. This will open the *Incidence Pooling and Aggregation* window.

- Change the name of the Pooling Window Name to *Short-Term Mortality* and press tab. The pooling window tab should now be named *Short-Term Mortality*.



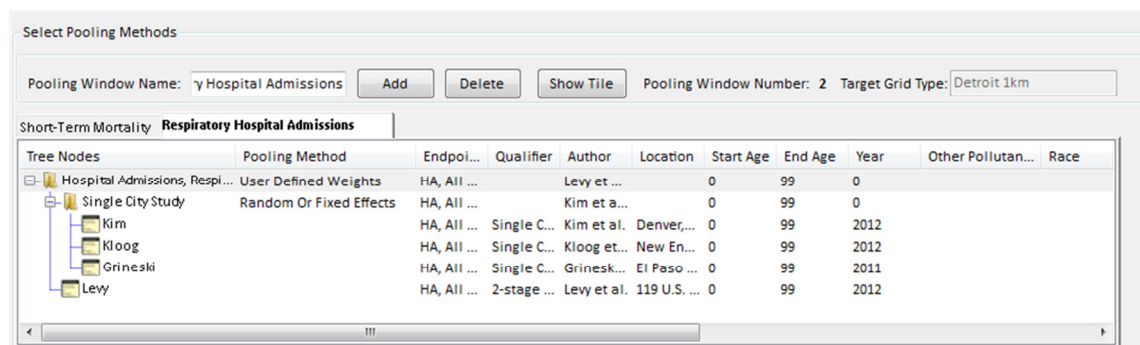
- Click, hold and drag the *Mortality, All-Cause* box from the top window to the bottom window.
- Click *Add* to insert a new pooling window. Change the name of the new pooling window to *Respiratory Hospital Admissions*.
- Click, hold and drag the four *HA, All Respiratory Hospital Admission* boxes from the top window to the bottom window.

Your screen should now look like this:



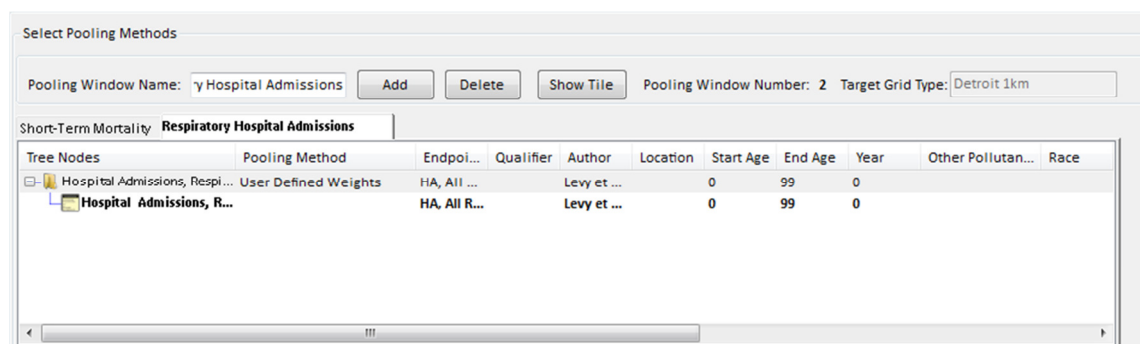
- Next, click hold and drag the *Qualifier* column to between the *Endpoint* and *Author*. This will group the single-city studies together.
- Click in cell of the *Pooling Method* column of the bottom window to pool the single-city studies using **Random Or Fixed Effect**.
- Now, pool the results of the single-city studies with the results of the two-stage meta-analysis using **User Defined Weights**.

Your screen should now look like this:

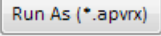


- Select **Condensed View** to see a preview of how the pooling options you selected will result in a single estimate.

Your screen should now look like this:





- Click *Next*. The next window prompts you to select weights to assign to the pooled single city studies and the 2-stage meta-analysis.
- Click *OK* to accept the default weights.
- The next window will prompt you to select economic valuation functions – please continue on to Step 6 to do so.

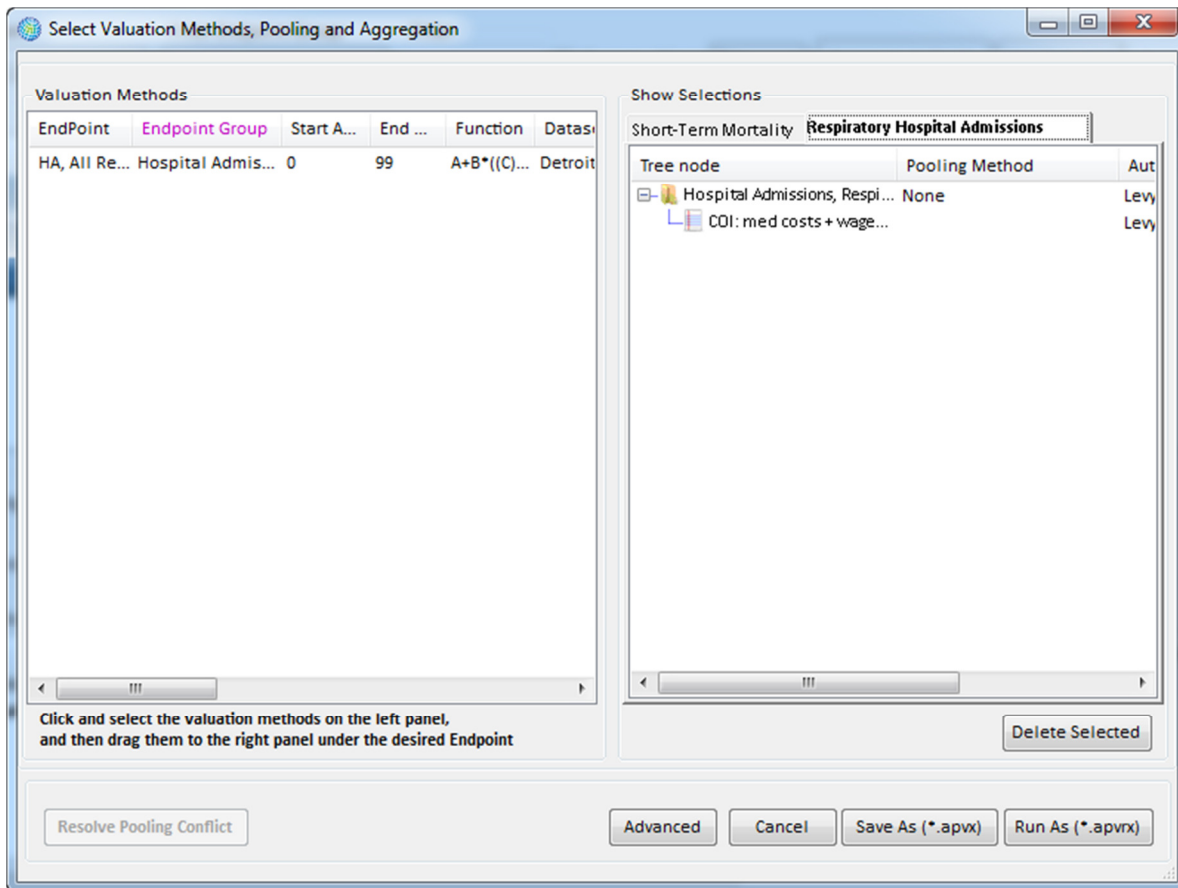
Note: If you don't want to monetize the health benefits, click  to generate pooled incidence results and go to Step 7 now to generate reports for the incidence results from the APVRX file you just created. If you would like to estimate economic values, proceed.

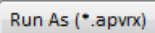
Step 6. Estimating Economic Values

As described above, the APV Configuration (.apvx) is a reusable file that records your aggregation, pooling and valuation choices. In this section, you will learn how to select and apply economic valuation functions, which assign a dollar value to the pooled and aggregated health impacts you estimated in the step above.

- **Select the Valuation Method.** Note that the pooling windows you created in the previous step are now located in the upper right-hand corner of the window. The left-hand side of the window lists the available valuation functions for the *Short-Term Mortality* pooling window.
- Find *Detroit Valuation Functions* in *Dataset Name*. Click, hold and drag this function directly below the  icon to assign the valuation function to this endpoint.
- Click the *Respiratory Hospital Admissions* pooling window tab. Find *Detroit Valuation Functions* in *Dataset Name*. Click, hold and drag this function directly below the  icon to assign the value function to this endpoint.

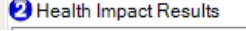



Your screen should now look something like this:



- Click the  button. When prompted to save the .apvx file, click *Yes* and title the file *Detroit Incidence and Valuation Results*.

Step 7. Generate Reports

Generate Tabular Reports from Configuration Results (.CFGRX): Recall that the configuration results files contain “raw” health impact estimates that you have not yet aggregated, pooled or valued. BenMAP-CE can generate tables, maps and bar charts of your data.

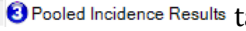

- Click the  Health Impact Results tab in the upper portion of the screen.
- Double click on the *Hospital Admissions, All Respiratory* result for the *Kloog* study.
- Making sure that the  GIS Map tab is active, you should now see the results of the *Kloog* study at each grid cell in the Detroit 1km grid (In order to see the *Health Impact Results* layer you may have to turn off the *Pollutants* layer by un-checking the box next to *Pollutants* in the map’s table of contents). If you’d like, you may select  to export shapefiles of the map layers.
- Next click on the  Data tab to view the health impact estimates at each 1km grid cell.
- Click on the *Aggregation for raw data* drop-down menu, and select *Detroit Counties* to aggregate these data to the county level.
- Click the *Select Result Fields* button to open the *Result Fields* window.
- In the *Result Fields*: window, check *Population Weighted Delta*. This will add a column to your table that reports the population-weighted air quality change for the air quality scenario. Click *OK*.

Your screen should now look something like this:

Column	Row	Endpoint	Author	Start Age	End Age	Point Estimate	Population	Delta
0	0	Population...	Kloog e...	0	99	0.5085	0.0000	0.0000
26	99	HA, All Res...	Kloog e...	0	99	0.3630	747,871.1000	0.5594
26	125	HA, All Res...	Kloog e...	0	99	0.3342	1,165,088.0000	0.3496
26	163	HA, All Res...	Kloog e...	0	99	2.6116	1,835,904.0000	0.6478
26	93	HA, All Res...	Kloog e...	0	99	0.0012	14,612.3200	0.1318
26	161	HA, All Res...	Kloog e...	0	99	0.0504	267,604.4000	0.2442
26	115	HA, All Res...	Kloog e...	0	99	0.0165	104,704.5000	0.2042
26	91	HA, All Res...	Kloog e...	0	99	0.0002	1,810.4630	0.1446

- Select *Output* if you would like to save your tabular data in .csv format.

Generate Tabular Reports from Aggregation, Pooling and Valuation (.APVRX): These results reflect the choices you made about how to aggregate, pool and value your results.

- Click the  Pooled Incidence Results tab in the upper portion of the screen.
- The *Short-Term Mortality* and *Respiratory Hospital Admissions* results should appear in the window at the bottom of the screen. If not, shift-click the *Short-Term Mortality* and *Respiratory Hospital Admissions* results, and then click *Show results*.
- Making sure that the  Data tab is active, you should now see the summarized health impact estimates in each county. Notice that you cannot re-aggregate the results in this stage, because you have already defined how to aggregate the results in Step 6 above.

- Next, click the **Pooled Valuation Results** tab in the upper portion of the screen.
- Click the *Column Headers* button and select the check box next to *Only show user-assigned percentiles*. Type *2.5,97.5* into this box. Click *OK*.

Your screen should now look something like this:

Column	Row	Endpoint	Author	Start Age	End Age	Version	Point Estimate	Mean	Standard Deviation	Variance	Percentile 2.5	Percentile 97.5
26	99	Mortality...	Zanobe...	0	99	1	61,508,800.0000	19.34...	6,120,353.0000	37,458,710,...	0.2757	38.3824
26	125	Mortality...	Zanobe...	0	99	1	58,197,760.0000	18.30...	5,790,892.0000	33,534,430,...	0.2609	36.3186
26	163	Mortality...	Zanobe...	0	99	1	184,331,100.0000	57.96...	18,341,620.0000	336,415,00...	0.8264	115.0129
26	93	Mortality...	Zanobe...	0	99	1	291,760.9000	0.0918	29,031.2800	842,815,40...	0.0013	0.1821
26	161	Mortality...	Zanobe...	0	99	1	9,217,186.0000	2.8988	917,144.0000	841,153,10...	0.0413	5.7523
26	115	Mortality...	Zanobe...	0	99	1	3,217,669.0000	1.0120	320,169.9000	102,508,80...	0.0144	2.0081
26	91	Mortality...	Zanobe...	0	99	1	40,527.8200	0.0127	4,032.6670	16,262,410...	0.0002	0.0253
26	99	HA, All Res...	Levy et ...	0	99		3,051.9990	2.833...	2,763.8460	7,638,847.0...	-1,601.2390	8,094.0470
26	125	HA, All Res...	Levy et ...	0	99		2,809.6640	2.608...	2,544.4640	6,474,298.0...	-1,473.9830	7,451.7440
26	163	HA, All Res...	Levy et ...	0	99		21,959.8800	20.38...	19,885.6700	395,439.90...	-11,522.7100	58,234.0500
26	93	HA, All Res...	Levy et ...	0	99		10.0735	9.3512	9.1230	83.2288	-5.2841	26.7185
26	161	HA, All Res...	Levy et ...	0	99		423.5804	393.2...	383.6071	147,154.4000	-222.2019	1,123.4540
26	115	HA, All Res...	Levy et ...	0	99		138.4686	128.5...	125.4022	15,725.7000	-72.6366	367.2621
26	91	HA, All Res...	Levy et ...	0	99		1.7043	1.5821	1.5435	2.3824	-0.8940	4.5204

- Select *Output* if you would like to save your tabular data in .csv format.

Generate Audit Trail Reports: Audit Trail Reports facilitate transparency and reproducibility by reporting a summary of your assumptions underlying each of five types of files generated by BenMAP-CE: Air Quality Grids (with the “.aqgx” extension), Incidence Configurations (with the “.cfgx” extension), Configuration Results (with the “.cfgrx” extension), Aggregation, Pooling, and Valuation Configurations (with the “.apvx” extension), and Aggregation, Pooling, and Valuation Results (with the “.apvrx” extension). We encourage you strongly to generate an audit trail for each BenMAP-CE analysis you perform, and to save the resulting file with the rest of the program outputs.

- Click the **Audit Trail Report** in the upper portion of the window. Select *Current Audit Trail Report*. Click *OK*.
- Carefully review the report, ensuring that the air quality grids, population data, health incidence data, health impact functions and economic value estimates appear as you expected.
- Click *Output* to save the audit trail report.

Appendix A. Health Impact Function Editor

In Step 2, you learned to add a health impact function dataset to BenMAP-CE. While the database of existing health impact functions is quite large, you may want to add your own; this guide will walk you through the steps.

- Start BenMAP-CE
- Choose the *Detroit* setup.
- Click *Modify Datasets*. This will bring up the *Modify Datasets* window.
- Click the *Manage* button under the *Health Impact Datasets* box. This will bring up the *Manage Health Impact Function Datasets* window.
- Click the *Edit* button. This will bring up the *Health Impact Function Dataset Definition* window.
- Click the *Add* button. This will bring up the *Health Impact Function Definition* window.
- Fill in the lists and boxes on the left-hand side of the window (you can use the drop-down menu):

Endpoint Group: Mortality
Endpoint: Mortality, All Cause
Pollutant: PM2.5
Metric: D24HourMean
Seasonal Metric: Blank
Annual Statistic: None
Race: ALL
Ethnicity: ALL
Gender: ALL
Start Age: 0
End Age: 99
Author: Zanobetti et al.
Year: 2009
Location: Detroit
Qualifier: Bayesian Shrunk Estimate

- Under the *Function* tab, double-click the following function:
$$\left(1 - \frac{1}{\text{EXP}(\text{Beta} \cdot \text{DELTAQ})}\right) \cdot \text{Incidence} \cdot \text{POP} \cdot A$$
. The function will then appear in the *Function* box.
- Choose *Normal* from the *Beta Distribution* list. The *Edit Distribution Values* window will appear.
- Enter the value 0.000678 in the *Mean Value* box. Also, enter the value 0.000406 for the *Beta Standard Error* in the *sigma* box. Click *OK*.
- In the *Constant Description* box for *A*, enter “Scalar to convert annual mortality rate to daily rate”. In the *Constant Value* box for *A*, enter 0.0027397. The mortality incidence rates in BenMAP-CE are specified as annual rates, and this conversion factor (1/365) is used to convert the rate to a daily rate for use in this function.

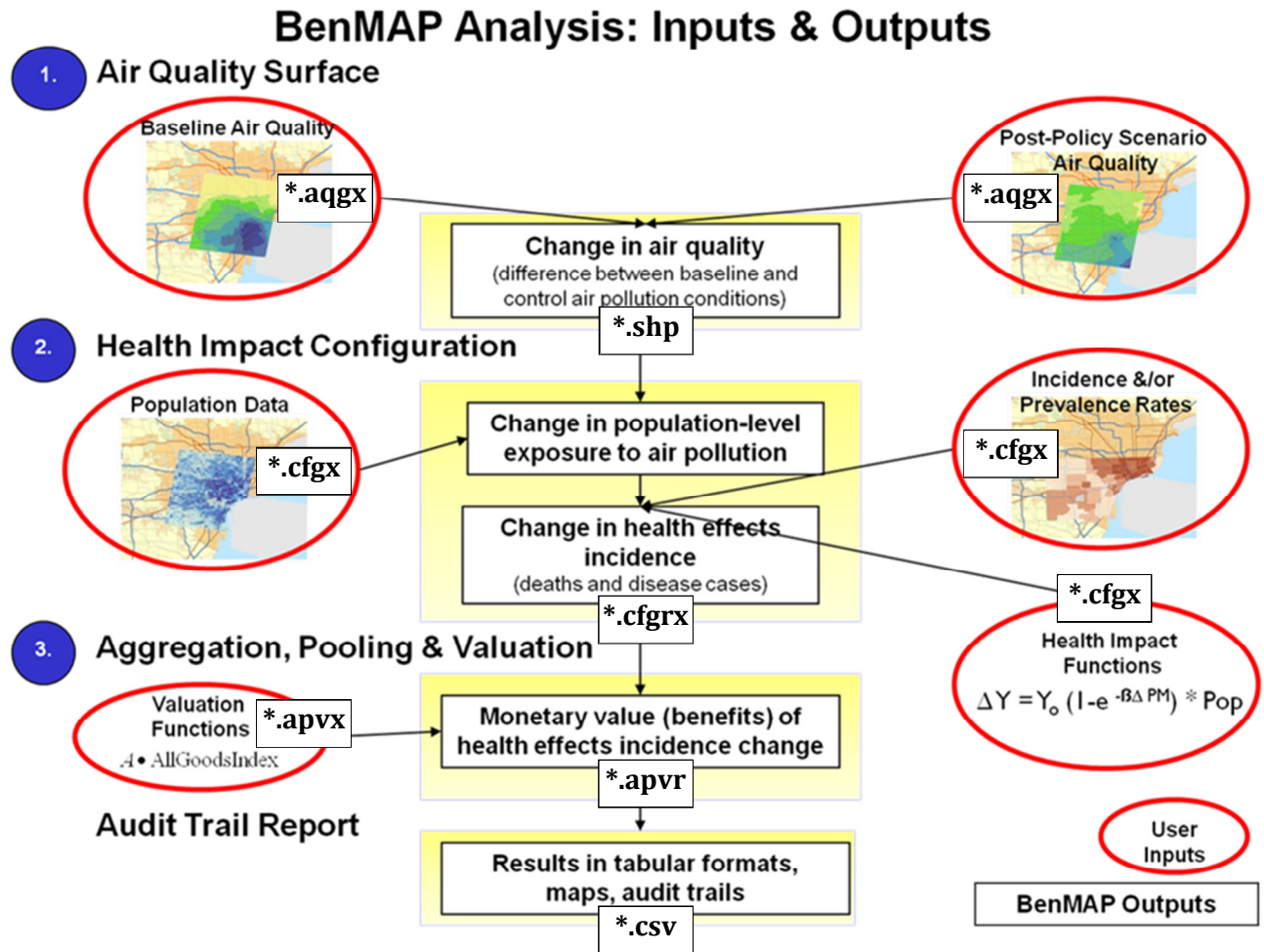
- Your screen should now look like this:

- Click *OK*. This will take you back to the *Health Impact Function Dataset Definition* window.
- You should now see your health impact function in the *Health Impact Function Dataset* window. Your function is now ready to use in an analysis.

Frequently Asked Questions about BenMAP-CE

1. What are the file types commonly used in BenMAP-CE?

The following figure depicts BenMAP-CE file types. See the table on the following page for a more detailed description of each file type and its default folder location.



File Extension	Description	Default Folder Location
*.aqgx	Air quality grid	Result\AQG
*.cfgx	Configuration specifying the health impact functions and other options used to generate incidence estimates.	Result\CFG
*.cfgrx	Configuration results, containing incidence results at the grid cell level.	Result\CFGR
*.apvx	Aggregation, Pooling, and Valuation configuration specifying the aggregation level, pooling options, and valuation methods used to generate pooled incidence and pooled valuation results.	Result\APV
*.apvr	Aggregation, Pooling and Valuation results, containing pooled incidence and pooled valuation results.	Result\APVR
*.shp	Shapefiles generated by BenMAP-CE's mapping capabilities. These files can be viewed within BenMAP-CE or within a GIS program, such as ArcGIS.	Result\AQG
*.csv	Reports are exported as *.csv files, which may be viewed in a text editor or in programs such as Excel.	Result\CFGR Result\APVR

2. What should I do when encountering error messages in BenMAP-CE?

There are generally two types of error messages BenMAP-CE could generate: user's error and system error. The user's error can be solved if the user operates BenMAP-CE correctly. When you encounter an error message, try to take a step back (e.g., remove the dataset you just added) and then re-do that step. Sometimes it is helpful to exit BenMAP-CE and re-start it. If you think it is a system error, you can report it at <http://www.epa.gov/air/benmap/beta.html> or send an email to benmap@epa.gov. You may also report errors and other suggested improvements using BenMAP-CE's new User Feedback form which is located in the Tools menu.

3. I added one or more datasets to BenMAP-CE and then exited BenMAP-CE to do something else. When I came back to continue my training, the datasets I added were gone.

You probably didn't save your work properly before you exited BenMAP-CE. Make sure you click the *OK* button in the *Modify Datasets* window (in the lower-right corner of the window) to save the datasets you added before you exit BenMAP-CE.

4. I've loaded new baseline incidence data, but BenMAP-CE won't let me select it in the configuration stage.

When formatting these data for importation to BenMAP-CE, take special care to ensure that you have specified the health endpoints correctly. The baseline incidence rate must be associated with a specific health endpoint and endpoint group in BenMAP-CE. Be sure that you have recorded the endpoint group and endpoint exactly as it is recorded in BenMAP-CE. For example, if the baseline incidence rate is for asthma-related hospital admissions, be sure you have recorded the endpoint

group as "Hospital Admissions, Asthma" and the endpoint as "HA, Asthma".

5. Can I use air quality grids based on different grid definitions in the baseline and control scenarios?

No. In any given analysis, you need to use the same grid definition in the baseline and control scenarios.

6. How do I know which health impact functions to use? Which functions does EPA use?

One option regarding the choice of health impact functions is to work with someone, for example another BenMAP-CE user, who is familiar with the epidemiological literature and develop your own set of health impact functions. Reviewing the epidemiological literature can be time-consuming, though in some situations this might be the best option, such as if you want to estimate the health impacts of carbon monoxide exposure, for which BenMAP-CE does not have pre-installed health impact functions.

Another option is to use the ozone and PM_{2.5} configurations used by EPA. You can download BenMAP-CE versions of these configurations from <http://www.epa.gov/air/benmap/beta.html>. If desired you can edit this configuration and then save it under a different file name -- it is always a good idea to keep the original version, so you can go back to it if needed!

7. How do I know what year dollars were used?

You can find the answer in the Audit trail for the .apvrx file that you generated.

8. Who should I contact if I have other questions?

You can send email to benmap@epa.gov.