Quick Start Guide

December 3, 2013

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Introduction

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

Air pollution benefits assessment 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.

Highlight Box 1: 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

II. Quick Start Guide

We designed this Quick Start Guide 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. Look for this in early 2014. The examples we describe in this Quick Start Guide rely upon assumptions and input data that EPA has historically used in its analyses (see Highlight Box 2)—but you should feel free to use your own parameters instead.

Before you start using this Quick Start Guide, you need to have:

- BenMAP-CE installed on your computer (The BenMAP-CE installer is available at http://www.epa.gov/air/benmap/ce.html).

Other literature that you may find helpful include:

- 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.
- 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.

As you use this Quick Start Guide, keep in mind that the list of Likely 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 be able to:

- run BenMAP-CE to conduct a simple benefit analyses
- understand datasets and data formats required by BenMAP-CE.

Highlight Box 2: How Have EPA and Others Used BenMAP?

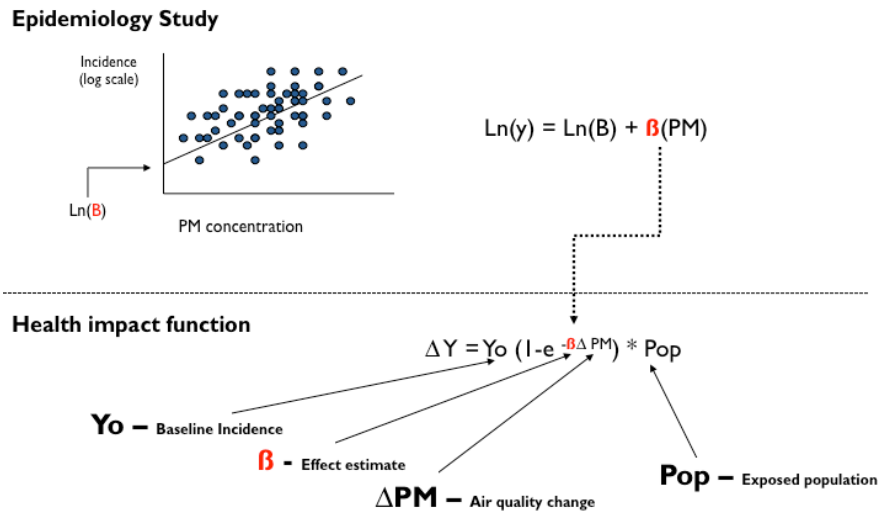
EPA and others have generally used BenMAP to answer two types of questions:

- 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
- 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.

Even before you begin using the BenMAP-CE software and following the Quick Start Guide, you may want to give some thought to the attributes of the community, region or nation in which you are performing the benefits assessment—including the types and levels of air pollutants, the demographic profile of the population, the health effect(s) that interest you, and the associated economic value of those health effects. If you are performing your analysis in the U.S., there's 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 referenced above can help you think through the types of considerations you might include in selecting studies from the epidemiological and economics literature. The BenMAP Flow Diagram shown in Figure 2 provides an overview of a BenMAP-CE analysis. This figure shows the types of choices that you will 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 have air quality modeling capabilities, and instead relies on externally created air quality modeling and monitoring data.

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

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



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

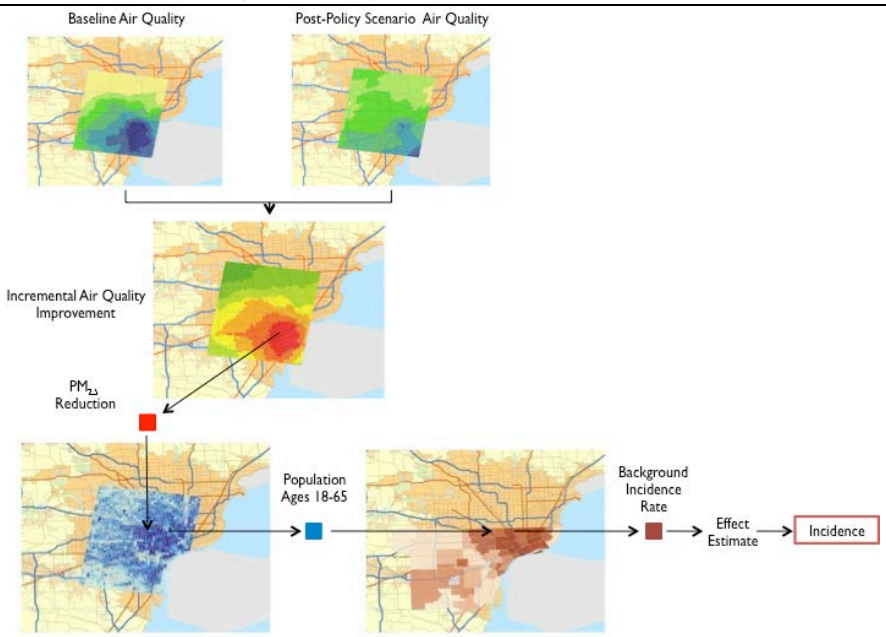
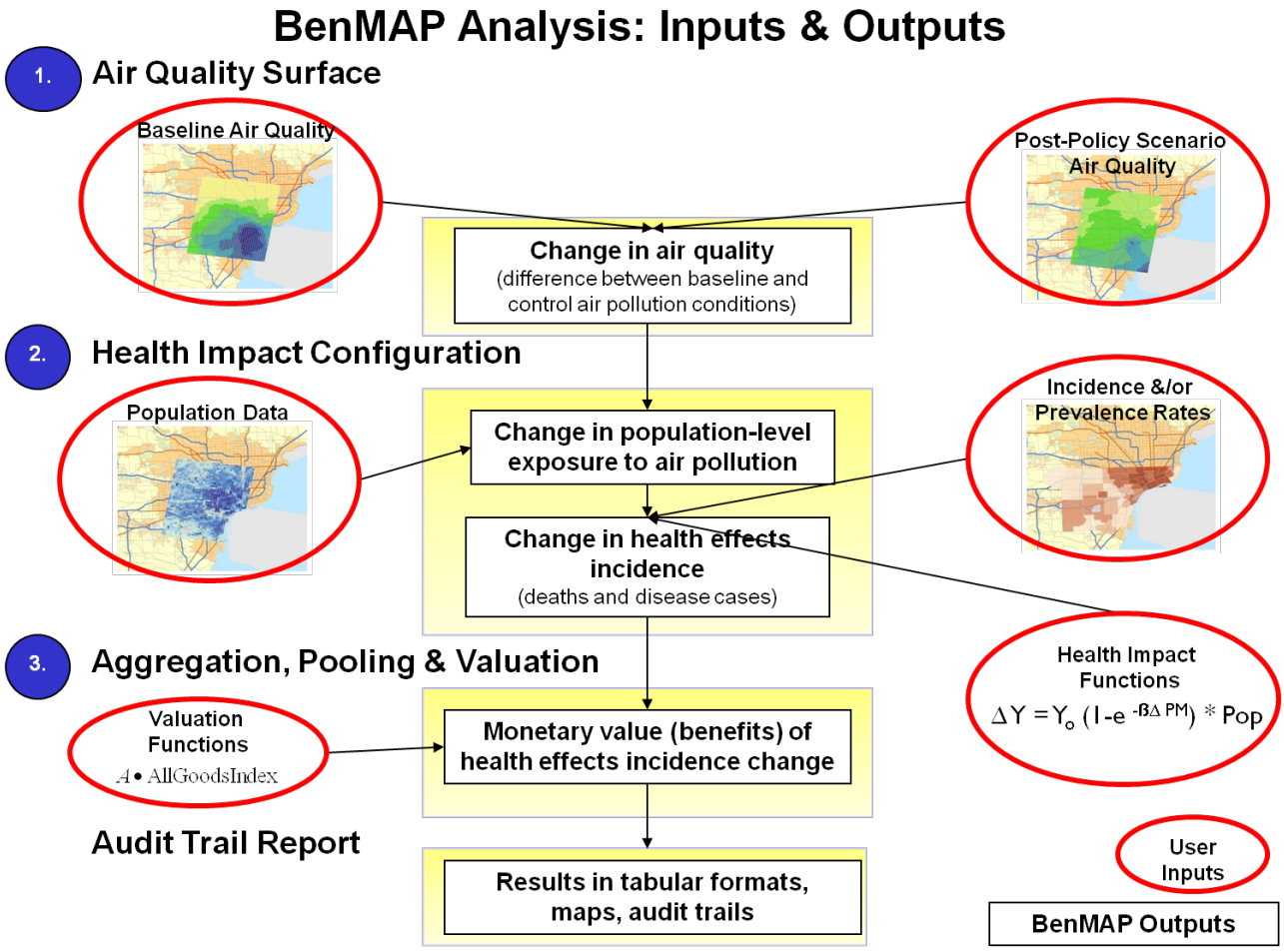


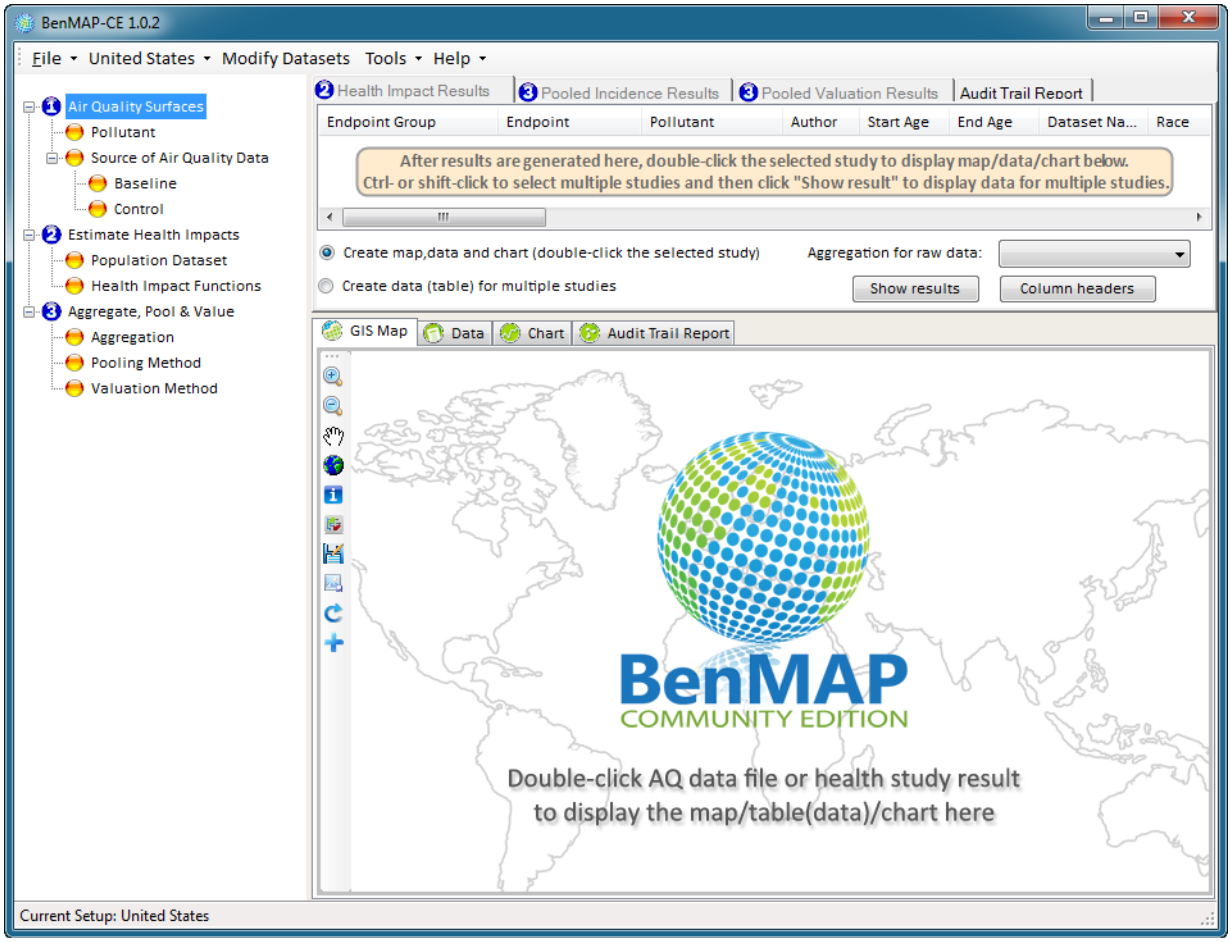
Figure 2: BenMAP-CE Flow Diagram



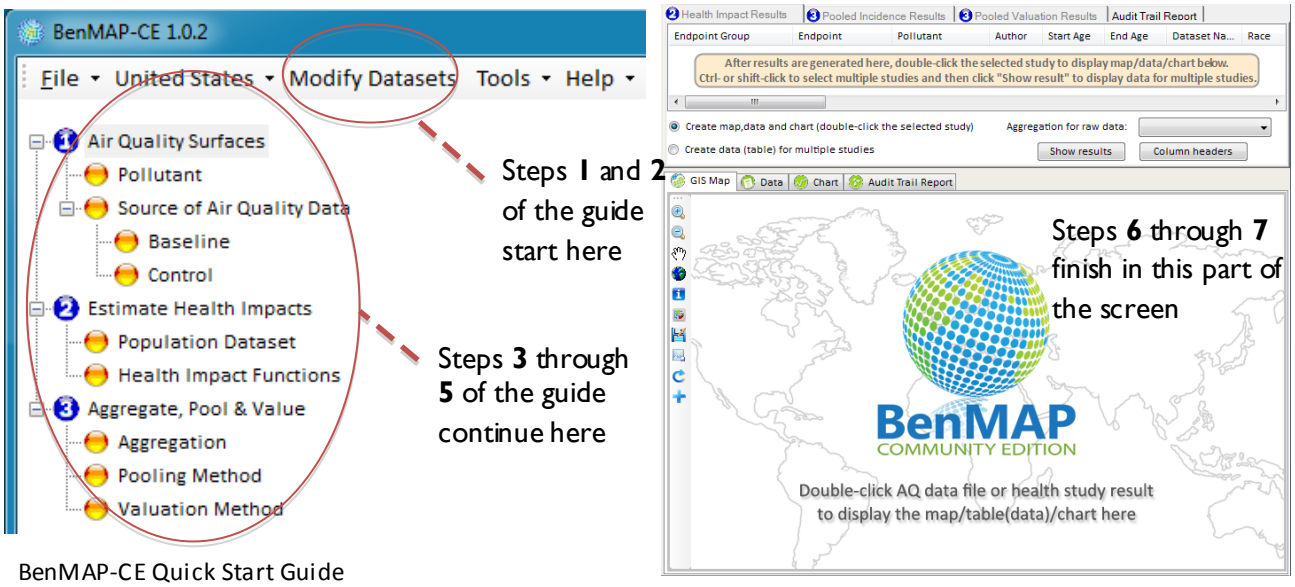
BenMAP-CE Main Window

These screenshots will help orient you to the BenMAP-CE user interface, and describe how the steps in the Quick Start Guide relate to the program components.

This is the BenMAP-CE main window…



…and here are the parts of the BenMAP-CE interface you will use in the Quick Start Guide.



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:

"Stoplight" color	Status
	Operation not yet started. The user should complete this step before moving to the next step in the sequence.
	Operation completed and requires no further attention. The user can proceed to the next step in the sequence.
	Operation completed, but the user may need to re-run this step.

Saving BenMAP-CE project 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:

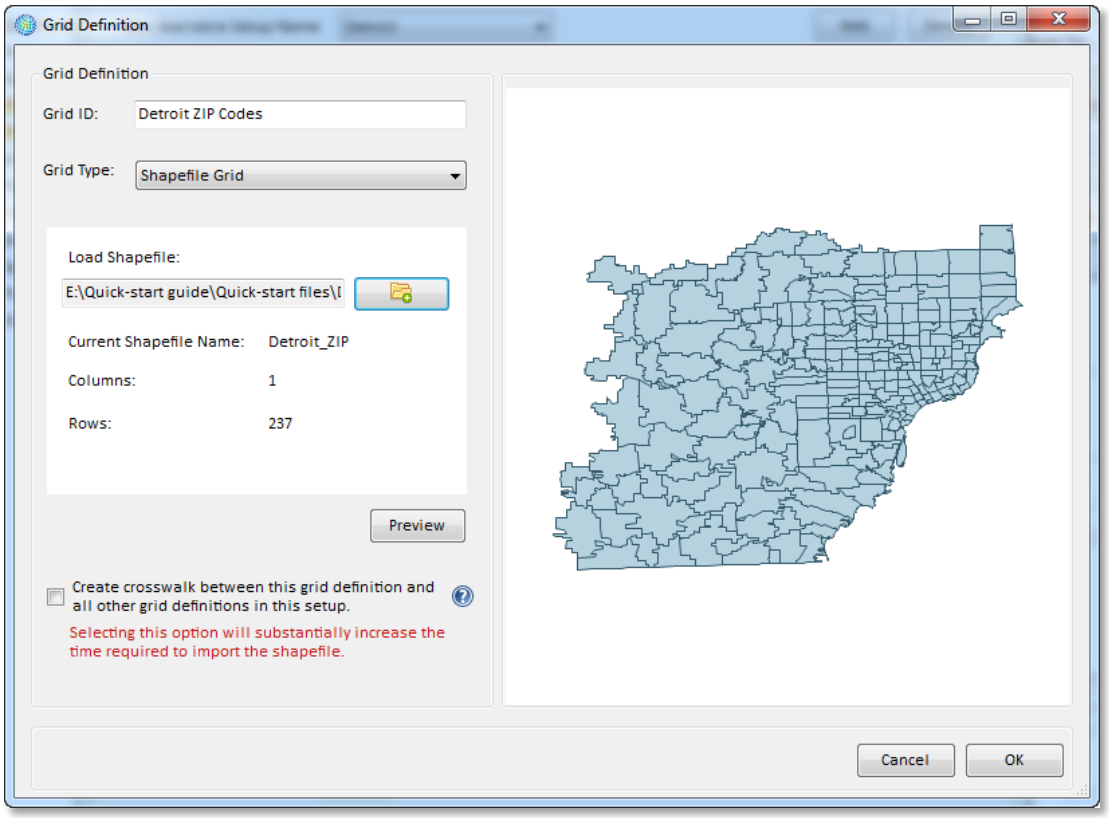
- Start BenMAP-CE
- Click *Modify Datasets* at the top left. This will bring up the *Modify Datasets* window.
- Click the *Add* button in the upper right corner of the window.
- Type *Detroit* into the *New Setup Name* box in the *New Setup* window and click the *OK* button.
- Confirm that *Detroit* is listed in the *Available Setups* 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. Select *Modify Datasets* in the upper left corner of the main BenMAP window. This will bring up the *Modify Datasets* window. Select *Detroit* from the drop down *Available Setups* menu and click the *Edit* 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.
- Confirm that the Grid Type is *Shapefile Grid.*

- Select the open folder icon  , and open the "Detroit_ZIP.shp" file in the Quick start data files. The Quick Start Guide files can be downloaded from http://www.epa.gov/air/benmap/models/Quick_Start_Data_Files.zip.
- Confirm that the Detroit ZIP codes map correctly in the preview window. Your screen should now look like this (the map color may vary):



- 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 in the *Manage Grid Definitions* window to return to the *Modify Datasets* window. 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 $PM_{2.5}$.

Define a pollutant

- In the *Modify Datasets* window for the Detroit setup, click the *Edit* 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.).

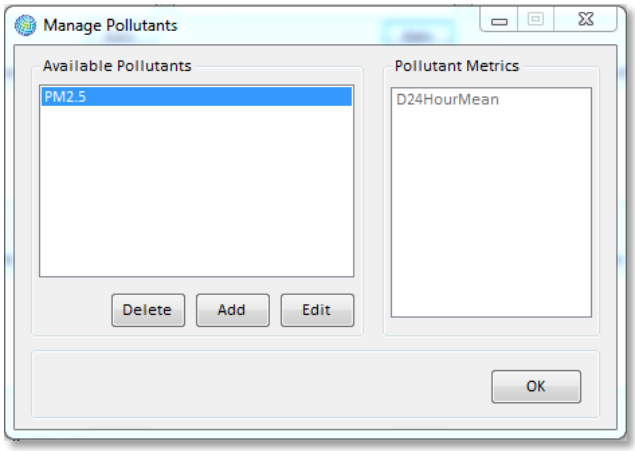
Define metrics for a pollutant: Observation Type

- 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 and also in the *Metric Name* 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 *Add* under the *Seasonal Metric Seasons* window. This will create a new season for this Seasonal Metric. Change the *End Date* value 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* box again. This will add a second season to the Seasonal Metric. Note that the *Start Date* value is automatically set to one day after the previous seasons *End Date* value. Change the *End Date* value for this second season to *June 30*.
- Click the *Add* button under the *Seasonal Metric Seasons* box again, and change the *End Date* value for this third season to *September 30*. Click the Add button under the *Seasonal Metric* Seasons a fourth time to add the 4th and final season. Note that there is no need to modify date values for this season.
- 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.
- Click the *OK* button to return to the *Manage Pollutants* window.

Your screen should now look like this:



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

Optional: You can go through the similar 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. Monitoring 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 – ambient air 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 ambient air monitoring data are stored in the setup database. Modeling data are loaded into BenMAP-CE when you conduct your analysis.

In the sample data files you downloaded, 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 pollutant concentrations separated by commas with missing values signified with a period ('.'), with the entire string of values enclosed by quotation marks.

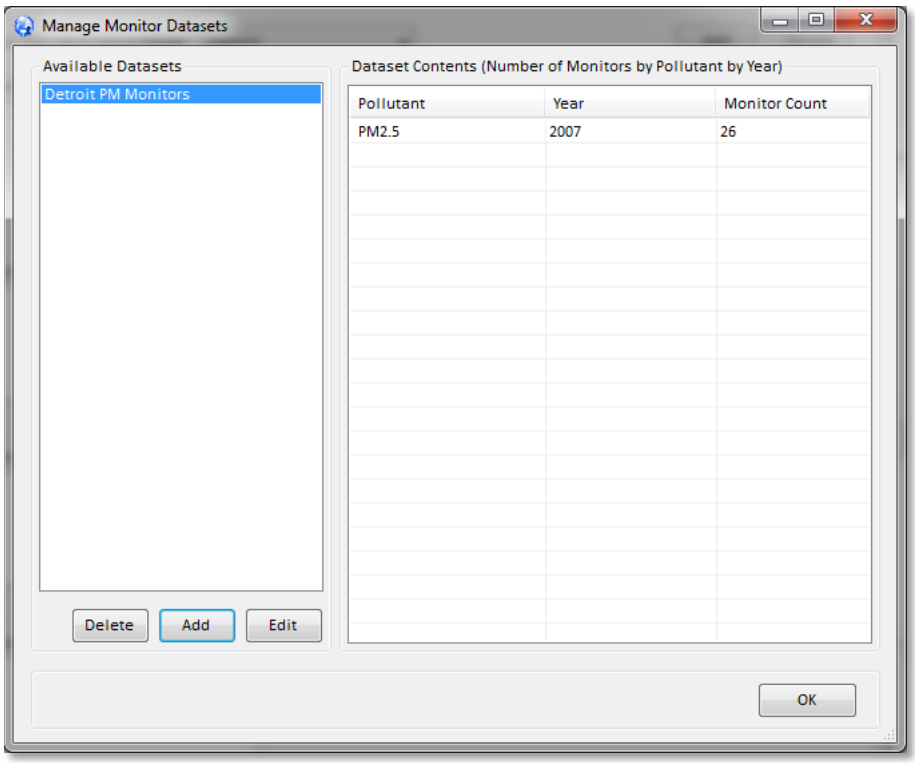
Now you can close the *Detroit Monitors PM25.csv* file and begin adding it to BenMAP-CE. Make sure you are in the *Modify Datasets* window and *Detroit* is selected in the *Available Setups* drop down.

- Click the *Edit* 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). If PM2.5 is the only pollutant you have defined, there will be only one pollutant in the drop down menu.

- In the *Year* box, type *2007* to indicate that your PM data are for the year 2007.
- Click on the *Monitor Data File* folder icon  , select *Detroit Monitors PM25.csv* file. Click *Open*.
- Click the *Import to Database* button. Click *Yes* in the *Confirm Edit* window that opens.
- Confirm that PM2.5 is now listed in the *Dataset Contents* box on the left side of the *Monitor Dataset Definition* window.
- Click *OK* to return to *Manage Monitor Datasets* screen.

Your Manage Monitor Datasets screen should look like the following:



- Click the *OK* button to return to the *Modify Datasets* window and you will see *Detroit PM Monitors* appearing in the *Monitor DataSets* box.

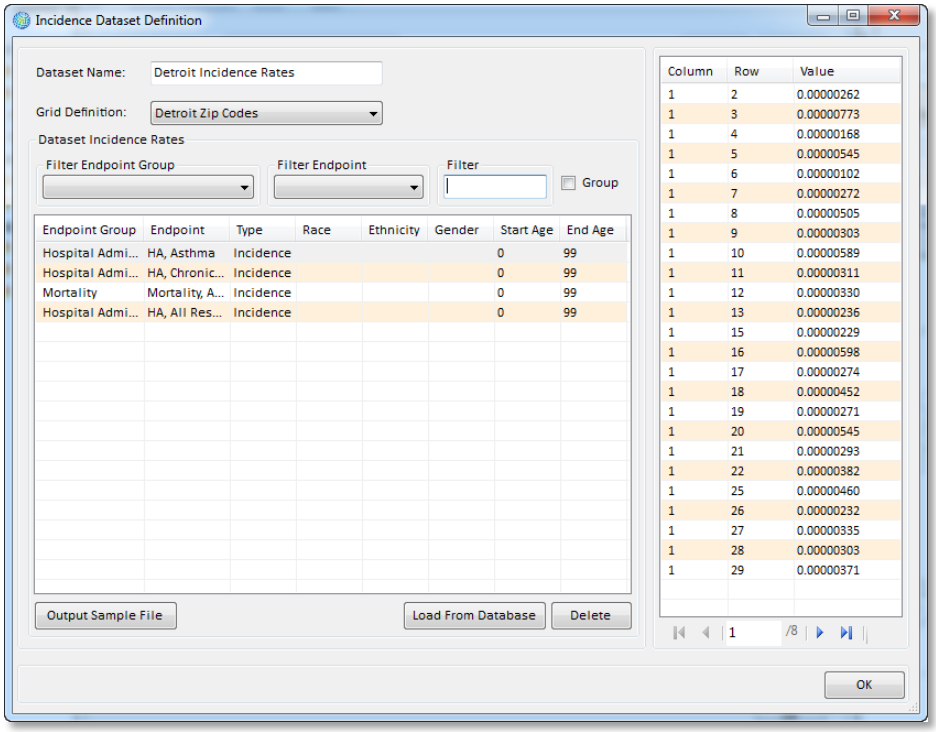
Note: If the purpose of your analysis is to examine air quality data, you can directly go to Step 3 now to create and map air quality grids. If you want to estimate health benefits, you will need to continue adding a few more datasets.

Incidence Data: The incidence rate is the number of health outcomes (e.g., number of hospital visits) per person, per unit of time (generally a day or a year)—from air pollution as well as all other causes. Locate and open *Detroit Incidence Rates.csv* from the Quick Start Data Files you downloaded. Note the configuration of the file in terms of column names and rows for future evaluations when you might be interested in incident rates for other endpoints or populations.

Now you can close the *.csv file 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 menu.

- Click the *Edit* button under the *Incidence/Prevalence Rates* box. This will bring up the *Manage Incidence Datasets* window.
- Click the *Add* button under the *Available Datasets* box. This will bring up the *Incidence Dataset Definition* window.
- In the *Dataset Name* box, type *Detroit Incidence Rates.* This will be the name of the new incidence dataset.
- Set the Grid Definition to *Detroit ZIP Codes*. Click the *Load from Database* button. This will bring up the *Load Incidence/Prevalence* window. Click *Browse* to locate the incidence dataset, entitled *Detroit Incidence Rates.csv*. Click *Open.*
- Click the *OK* button. Click *Yes* in the *Confirm* window to load the incidence dataset (this may take some time).

When BenMAP-CE finishes loading the data, your *Incidence Dataset Definition* window 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.

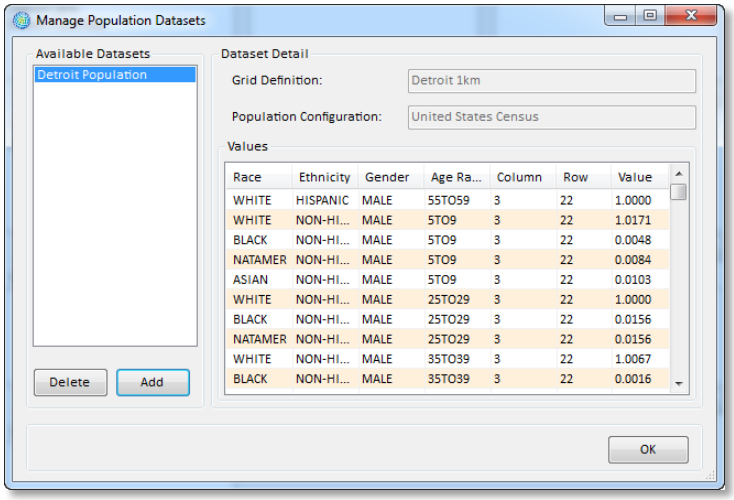
Population Data: You will be adding population data from a *.csv file. First view the population dataset entitled *Detroit Population.csv* in your Quick Start Data Files. The BenMAP-CE database includes U.S. population data gridded to a 12km domain that covers the Continental U.S., as well as county-level 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 *Edit* 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. Select the population configuration *United States Census* from the drop down list of *Population Configuration.* This tells BenMAP-CE how the demographic characteristics of your population are categorized.
- Click the *Browse* button next to the *Database* box. Select the *Detroit Population.csv* file. Click *Open.*
- Click *OK* in the *Load Population Dataset* window to load the file. Note that this could take several minutes as BenMAP-CE loads the data. When the data are finished loading, you will be returned to the *Manage Population Datasets* window.

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



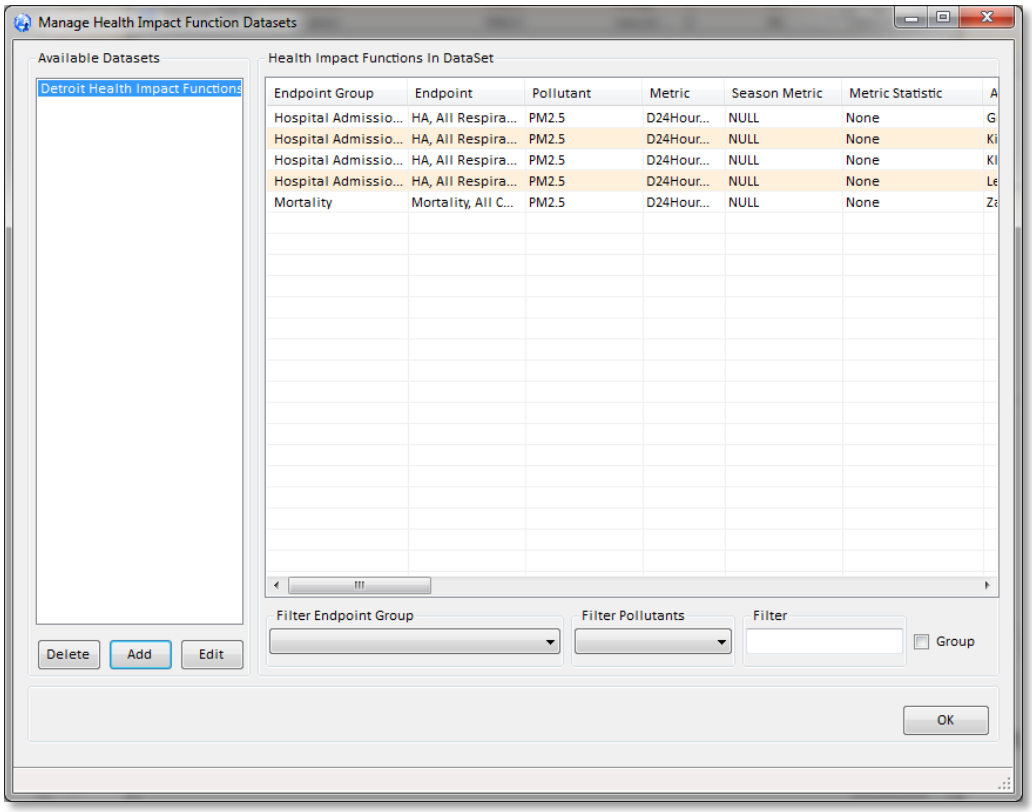
- Click *OK* to return to the *Modify Datasets* window. You will now see *Detroit Population* in the *Population Datasets* box.

Health Impact Functions: BenMAP-CE contains a large library of health impact functions developed using risk estimates reported in peer-reviewed epidemiological studies. Here you will be adding new health impact functions from a *.csv file. You can use a spreadsheet program if you wish to view the data format of the file *Detroit Health Impact Functions.csv* in your Quick Start Data Files.

Once you have seen the format of health functions, close the file *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 *Edit* 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 Database* button. Locate the *Detroit Health Impact Functions.csv* file. After locating the file, click *Open*. Click *OK* in the *Health Impact Function Dataset Definition* window. This will load the file and return you 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. You will now see *Detroit Health Impact Functions* in the *Health Impact Functions* box.

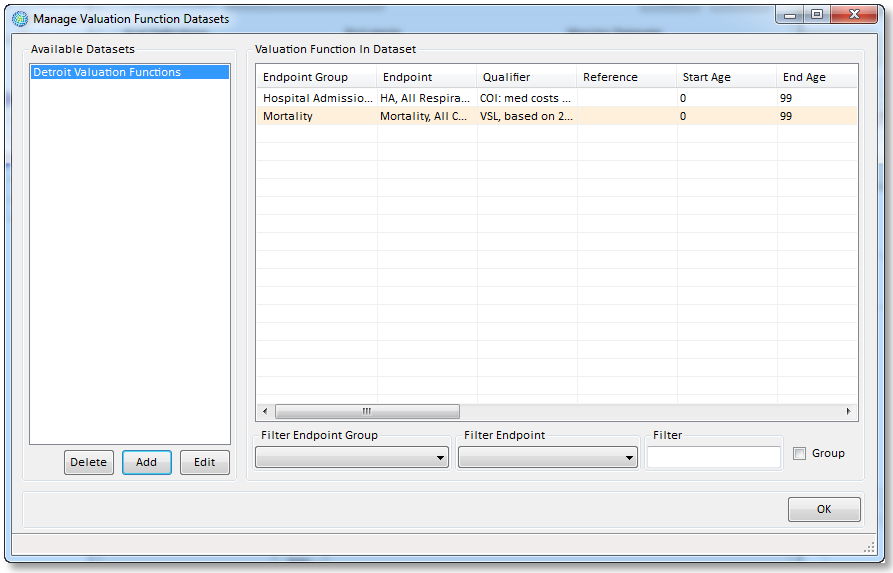
Note: If the purpose of your analysis is to generate incidence results only (i.e., you don't want to attach dollar values to the incidence results), you can go to Step 3 directly now. If you do want to estimate the economic value of the health impacts, you will need to continue adding a valuation function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

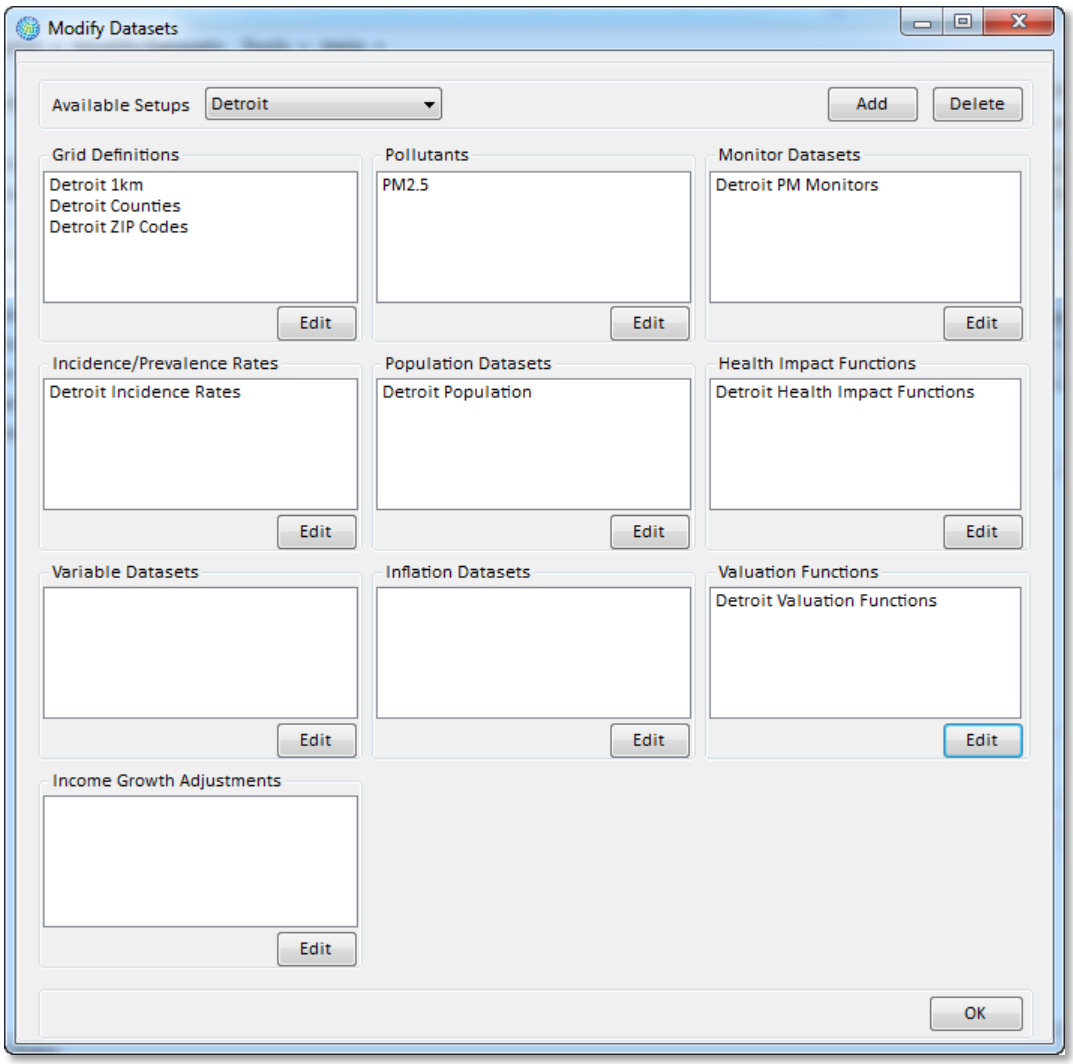
- Click the *Edit* button under the *Valuation Functions* box on the right side of the *Modify Datasets* screen. This will bring up the *Manage Valuation Function Datasets* window.
- Click the *Add* button under the *Available Datasets* box. This will bring up the *Valuation Function Dataset Definition* 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 Database* button, locate the *Detroit Valuation Functions.csv* file, and click *Open*.
- Click the *OK* button in the *Valuation Function Dataset Definition* window and this will load the file and return you 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. You will now see *Detroit Valuation Functions* in the *Valuation Functions* box.

Congratulations! You have completed adding all the datasets you will need for this training course. Your *Modify Datasets* 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.

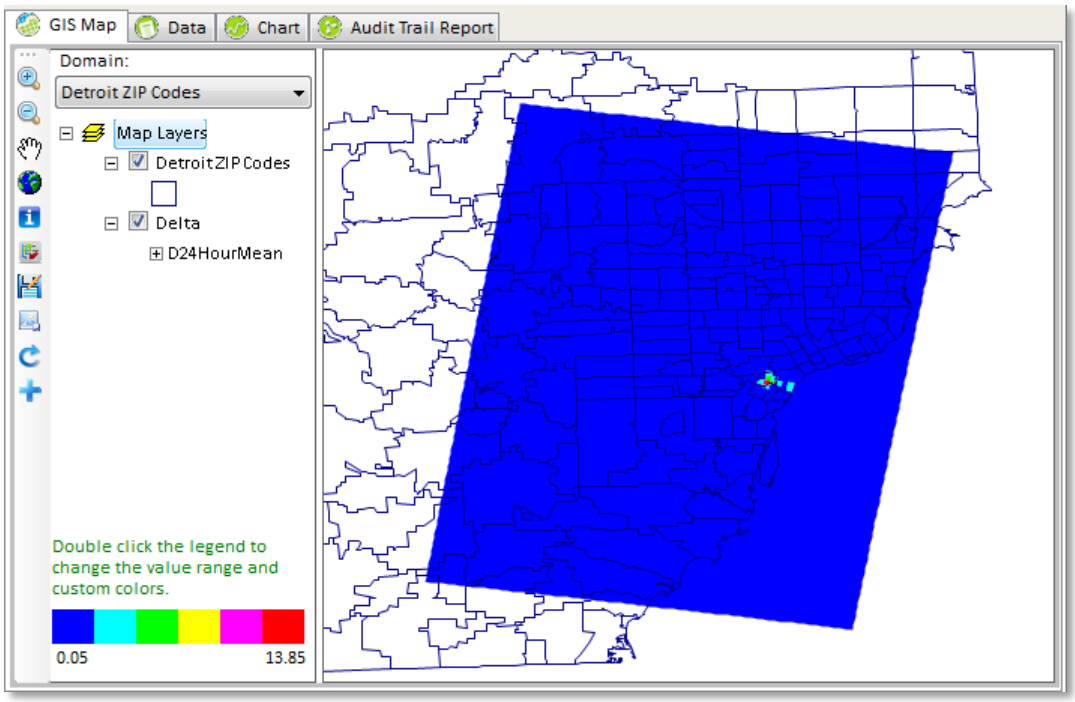
Step 3: Create Air Quality Grids

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 to the right of the *File* menu (the default value is *United States* and select *Detroit.* Verify that the *Current Setup* listed in the status bar at the bottom left corner of the window now says *Detroit.*
- On the left side of the main BenMAP window, double-click *Pollutant* to open the *Pollutant Definition* window. Click, hold and drag the PM2.5 pollutant from the left-hand window to the right-hand window. Click *OK*.
- Next, double-click *Baseline* on the left side of the main BenMAP window. You will see the *Choose a Grid Creation Method* window appear. Note that the *Grid Type* is set to *Detroit 1km* and that *Model Data* is selected as the Grid Type. Click *Next*.
- In the *Model Data* window, click the open folder icon  and select *Detroit Baseline.csv* in your Quick Start Data Files. Click *Open.* Click *OK* in the *Model Data* window.
- In the *Save As* window, give the baseline air quality grid a name: *Detroit Baseline*. Click *Save.* This will save the grid as a "*.aqgx" (air quality grid) type file.
- Repeat the steps above after double-clicking *Control* on the left side of the main BenMAP window, 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 delta (baseline – control)* and verify that the check box next to *Delta* (in the GIS Map tab map area of the window) is selected to view the difference between the baseline and control PM2.5 levels in each grid cell in the *GIS Map* window.

Confirm that the domain is Detroit ZIP Codes. If the domain is Detroit Counties, change the domain to Detroit ZIP Codes. The GIS Map section of your screen should look something like this:



- Determine the air quality change in one of the grid cells by using the *Identify* tool  Click on the icon and you will see a question mark (?) next to the cursor when you mouse over the map. Click on a location on the GIS map to bring up the *Identify* window. When finished, close the *Identify* window.
- Change the color values in the legend by double-clicking the color ramp. You can change the colors or the value range. Remember to click *Rebuild* if you change the value range.
- Save the shape (*.shp) file by selecting the *Save shapefile* icon  Choose a file name that is descriptive (such as "Detroit PM2.5 Air Quality Change"). The default save location is C:\ but you can choose a location easy to remember (such as a folder labeled "BenMAP Output Files"). Click *OK* in the *File Saved* window.

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.

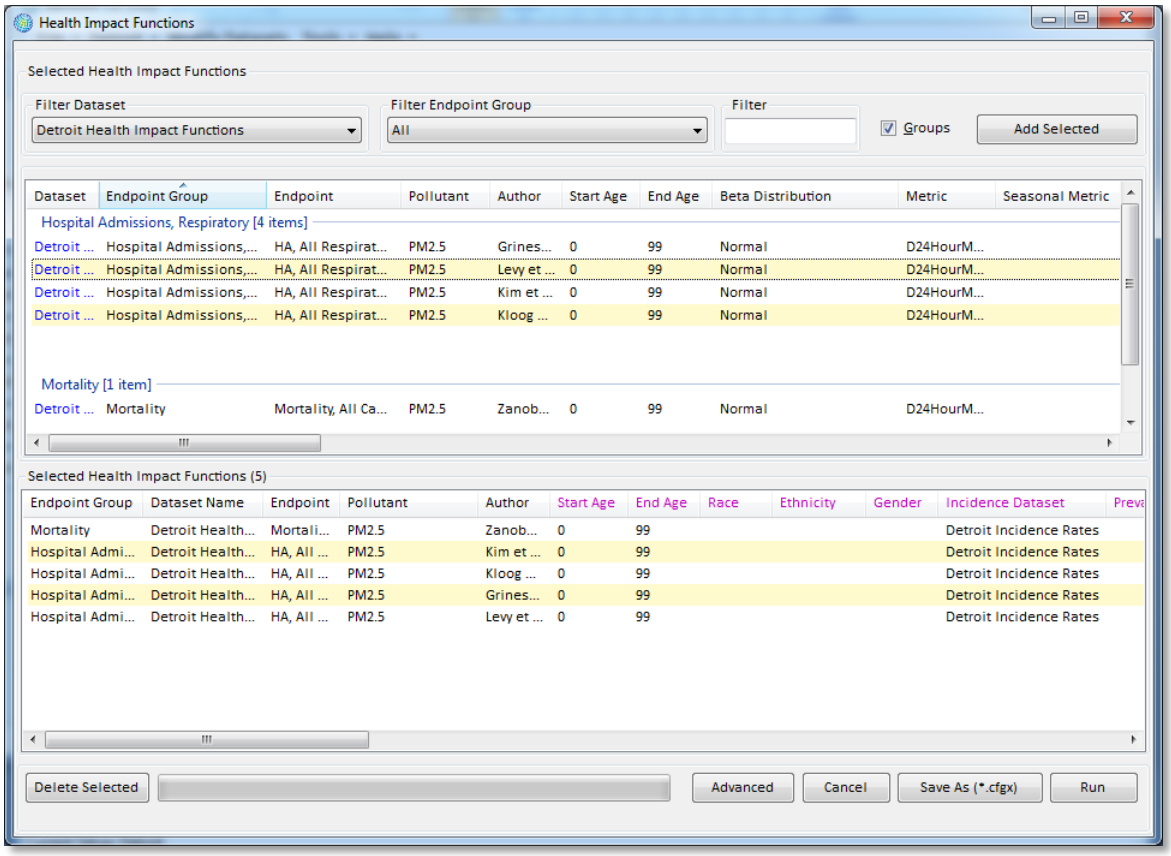
Step 4: Estimate Health Impacts

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 PM2.5 on premature deaths and respiratory hospital admissions.

- Make sure *Detroit* is selected in the drop down menu in the upper left corner of the BenMAP-CE main window next to *File*.
- Double-click the *Population Dataset* button on the left side of the window, where you will find that the *Population Dataset* window is preconfigured to *Detroit Population* and the *Population Year* is set to *2010*. Click *OK*.
- Next, double-click *Health Impact Functions*. You will see the *Health Impact Functions* window appear. 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 the 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 – one mortality function and four hospital admission functions):



- Click the *Run* button.
- When prompted to Run and save the CFG results file, click *Yes*. Save the file as *Detroit Configuration Results*. The default folder for saving the configuration results is My Documents/My BenMAP-CE Files/Result/CFGR. This step may require a few minutes to run.
- When BenMAP-CE finishes generating results, you will be returned to the BenMAP-CE main window.

Note: Using the CFGRX ("configuration results") 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, and

--You don't want to monetize the health benefits.

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

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).

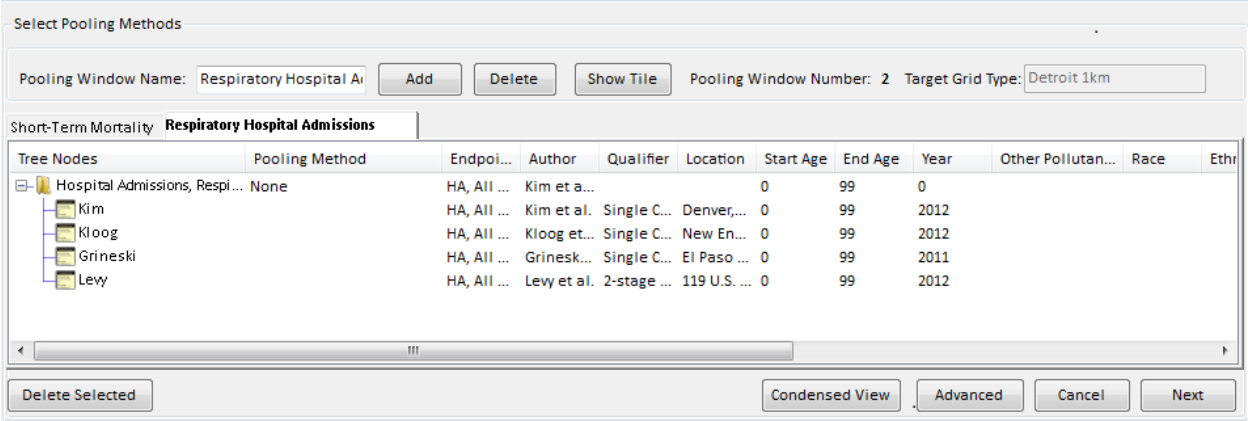
To create an APVX ("aggregation, pooling, valuation") file, BenMAP-CE works by first aggregating results to the level that you have specified. It then pools the aggregated incidence results. Finally it values the aggregated and pooled incidence. Here you will change the aggregation level from the 1km 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 on the left side of the main window. This will open the *Aggregation* window. Aggregate the incidence and valuation results to the *Detroit Counties* level in the drop down menus. Click *OK*.
- ***Pool results.*** Double-click the *Pooling Method* button on the left side of the main window. This will open the *Incidence Pooling and Aggregation* window.
- Change the name of the Pooling Window Name in the lower half of the window to *Short-Term Mortality* and click on the tab. The pooling window tab now displays

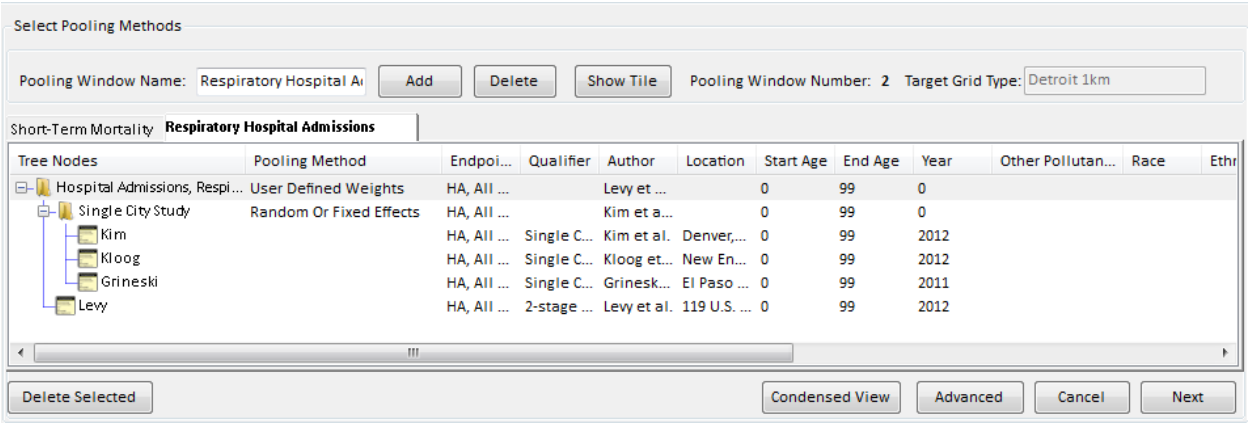
- Click, hold and drag the *Mortality, All-Cause* box from the top window to the bottom window.
- Click *Add* in the *Select Pooling Methods* section in the lower half of the window to insert a new pooling window. Change the name of the new pooling window to *Respiratory Hospital Admissions* and click on the tab to assign this new pooling to the tab.
- Click, hold and drag the four *HA, All Respiratory Hospital Admission* boxes from the top

window to the bottom window.

The lower half of your screen should now look like this:

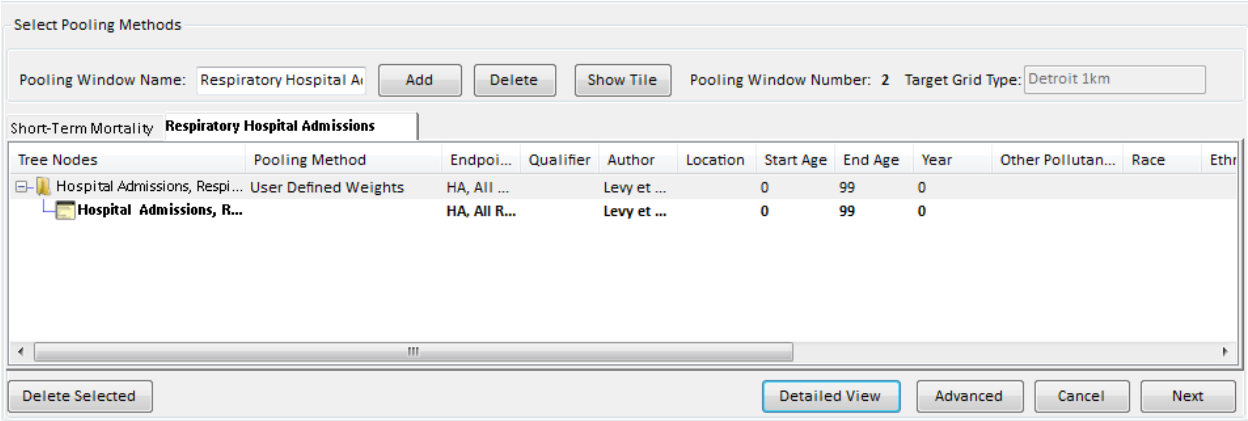


- Next, click hold and drag the *Qualifier* column in the bottom window to between the *Endpoint* and *Author*. This will group the single-city studies together.
- In the *Pooling Method* column of the bottom window, click on the word *None* in the row of the *Single City Study* Tree Node. This opens a drop down box. Select *Random or Fixed Effects* to pool the single-city studies.
- Click on the word *None* in the *Hospital Admissions, Respiratory* row, in the *Pooling Method* column. This opens a drop down box. Select *User Defined Weights.* This will pool the results of the single-city studies with the results of the two-stage meta-analysis. Your screen should now look like this:

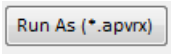


- Select Condensed View to see a preview of how the pooling options you selected will result in a single estimate.

Your screen should now look like this:



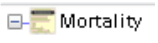
- Click *Next*. The next window (*Select User Defined Weight*) prompts you to select weights to assign to the pooled single city studies and the 2-stage meta-analysis. Click *OK* to accept the default weights.
- The next window (*Select Valuation Methods, Pooling and Aggregation*) will prompt you to select economic valuation functions.

Note: If you want to monetize the health benefits, proceed to Step 6. If you do not want to monetize the health benefits, , click 

to generate pooled incidence results. When prompted to save the APV results file (*.apvrx), click *Yes*. Save the file as *Detroit Aggregated and Pooled Results*. The default folder for saving the configuration results is My Documents/My BenMAP-CE Files/Result/APVR folder (in Windows XP). Once the file is saved, you will see a File saved confirmation window. Click *OK*. Then go directly to Step 7 to generate reports for the incidence results from the APVRX file you just created.

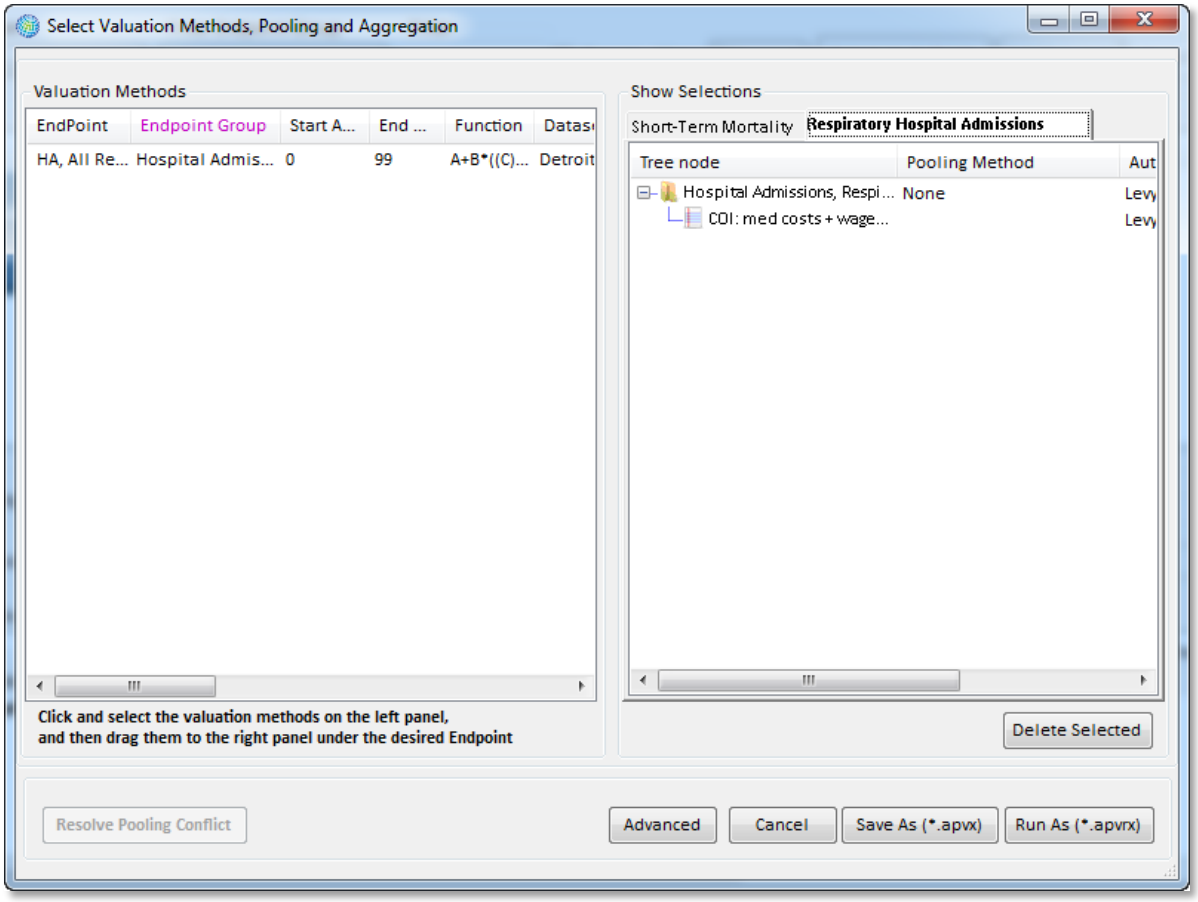
Step 6. Estimating Economic Values

As described above, the APV Configuration (*.apvx) is a reusable file that records your aggregating, pooling and valuing 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 shown as tabs 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* (you may have to expand the left-hand side of the window). Click, hold and drag this function directly below the 

icon on the right side of the window to assign the valuation function to this endpoint. When a purple line appears below the *Mortality* Tree Node, your drag is successful.
- Click the *Respiratory Hospital Admissions* pooling window tab. Find *Detroit Valuation Functions* in *Dataset Name*. Click, hold and drag this function directly below the

Hospital Admissions, Respi icon to assign the value function to this endpoint. Your screen should now look something like this:



- Click the Run As (*.apvrx) button. When prompted to save the APV results file (*.apvrx), click *Yes* and title the file *Detroit Incidence and Valuation Results*. The default folder for saving the aggregation, pooling and valuation results is My Documents/My BenMAP-CE Files/Result/APVR folder. Click *Save.* Click *OK* when the *File saved* confirmation window appears. You will be returned to the main window.

Step 7. Generate Reports

Generate Tabular Reports from Configuration Results (.CFGRX): Recall that the configuration results files (*.cfgrx) 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. Select  to export your shapefile. Give it an appropriate file name, and save it in a location easy to remember. Click OK when the *File saved* confirmation window appears.

- 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 in the middle of the window, and select *Detroit Counties* to aggregate these data to the county level.
- Click *Column Headers* in the middle of the window. The window *Configuration Results Report* appears. Click on the Field Name *Population Weighted Delta*, which 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:

GIS Map | Data | Chart | Audit Trail Report

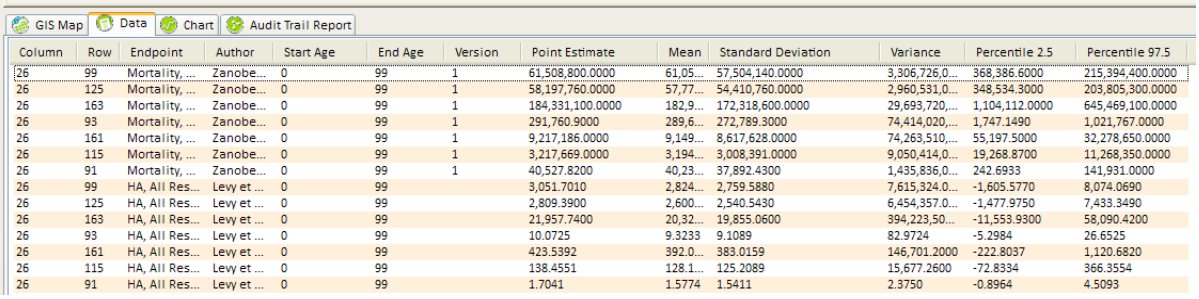
Column	Row	Endpoint	Author	Start Age	End Age	Point Estimate	Population	Delta
0	0	Population...	Kloog e...	0	99	0.5085	0.0000	0.0000
26	99	HA, All Res...	Kloog e...	0	99	0.3630	747,871.1000	0.5594
26	125	HA, All Res...	Kloog e...	0	99	0.3342	1,165,088.0000	0.3496
26	163	HA, All Res...	Kloog e...	0	99	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 (comma-separated values) format.

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

- Click the 3 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 3 Pooled Valuation Results tab in the upper portion of the screen.
- Click *Column Headers* and then select the check box next to *Only show user-assigned percentiles* in the lower left corner of the window. Type *2.5,97.5* into this box. Click *OK.*

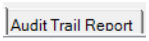
Your screen should now look something like this:



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	61,05...	57,504,140.0000	3,306,726,0...	368,386.6000	215,394,400.0000
26	125	Mortality, ...	Zanobe...	0	99	1	58,197,760.0000	57,77...	54,410,760.0000	2,960,531,0...	348,534.3000	203,805,300.0000
26	163	Mortality, ...	Zanobe...	0	99	1	184,331,100.0000	182,9...	172,318,600.0000	29,693,720,...	1,104,112.0000	645,469,100.0000
26	93	Mortality, ...	Zanobe...	0	99	1	291,760.9000	289,6...	272,789.3000	74,414,020,...	1,747.1490	1,021,767.0000
26	161	Mortality, ...	Zanobe...	0	99	1	9,217,186.0000	9,149...	8,617,628.0000	74,263,510,...	55,197.5000	32,278,650.0000
26	115	Mortality, ...	Zanobe...	0	99	1	3,217,669.0000	3,194...	3,008,391.0000	9,050,414,0...	19,268.8700	11,268,350.0000
26	91	Mortality, ...	Zanobe...	0	99	1	40,527.8200	40,23...	37,892.4300	1,435,836,0...	242.6933	141,931.0000
26	99	HA, All Res...	Levy et ...	0	99		3,051.7010	2,824...	2,759.5880	7,615,324.0...	-1,605.5770	8,074.0690
26	125	HA, All Res...	Levy et ...	0	99		2,809.3900	2,600...	2,540.5430	6,454,357.0...	-1,477.9750	7,433.3490
26	163	HA, All Res...	Levy et ...	0	99		21,957.7400	20,32...	19,855.0600	394,223,50...	-11,553.9300	58,090.4200
26	93	HA, All Res...	Levy et ...	0	99		10.0725	9.3233	9.1089	82.9724	-5.2984	26.6525
26	161	HA, All Res...	Levy et ...	0	99		423.5392	392.0...	383.0159	146,701.2000	-222.8037	1,120.6820
26	115	HA, All Res...	Levy et ...	0	99		138.4551	128.1...	125.2089	15,677.2600	-72.8334	366.3554
26	91	HA, All Res...	Levy et ...	0	99		1.7041	1.5774	1.5411	2.3750	-0.8964	4.5093

- 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 

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. The default location for saving *.ctlx files will be the location you chose earlier for saving your shape files.

Appendix A. Health Impact Function Editor

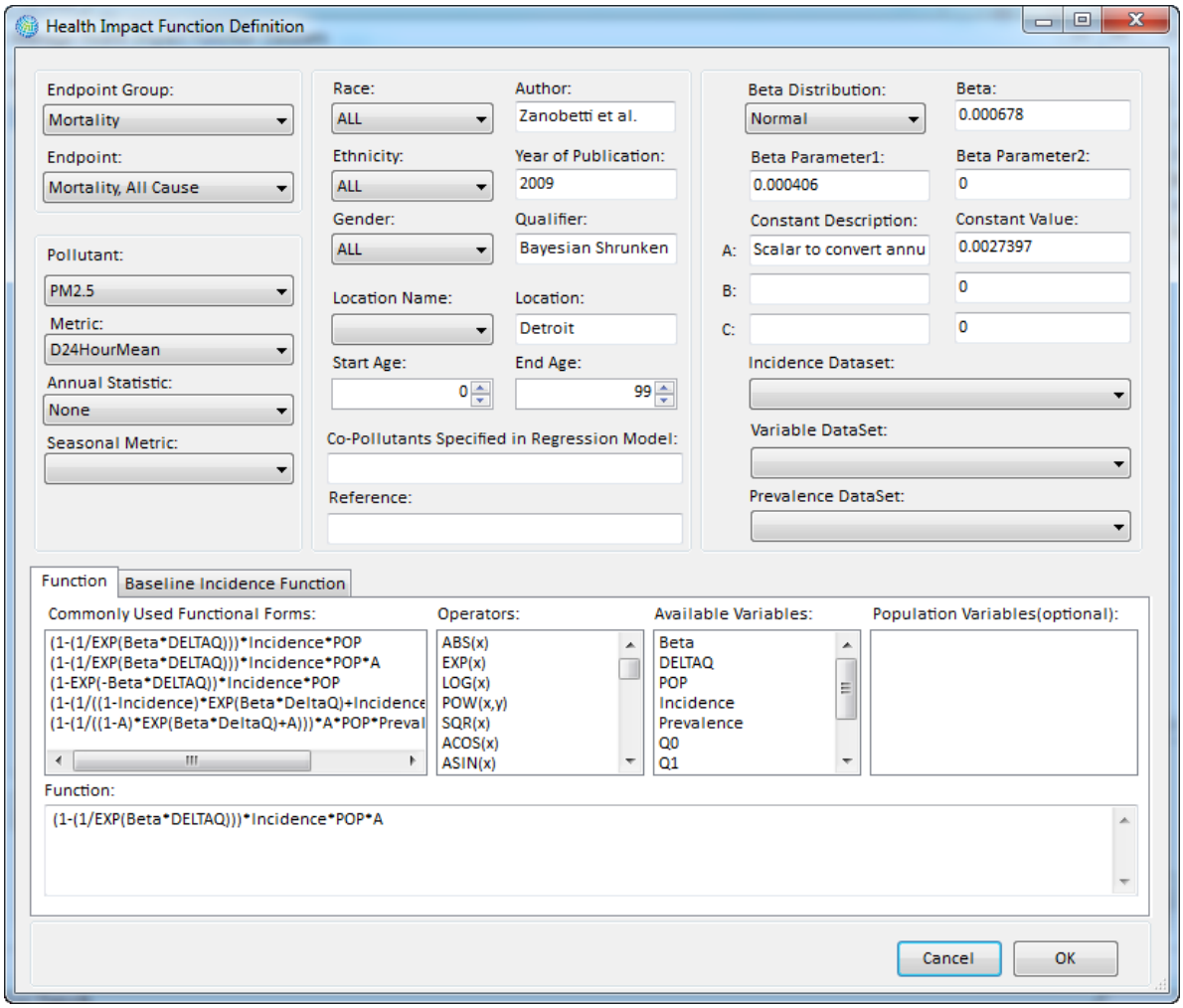
In Step 2, you learned to add a health impact function dataset to BenMAP-CE. While the database of existing health impact functions is quite large, you may want to add your own; this guide will walk you through the steps.

- Start BenMAP-CE
- Choose the *Detroit* setup.
- Click *Modify Datasets*. This will bring up the *Modify Datasets* window.
- Click the *Edit* button under the *Health Impact Functions* box. This will bring up the *Manage Health Impact Function Datasets* window.
- Click the *Edit* button under the *Available Datasets* box. 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
  Annual Statistic: None
  Seasonal Metric: Blank
  Race: ALL
  Ethnicity: ALL
  Gender: ALL
  Start Age: 0
  End Age: 99
  Author: Zanobetti et al.
  Year of Publication: 2009
  Qualifier: Bayesian Shrunken Estimate
  Location: Detroit

- Under the *Function* tab in the lower half of the window, double-click the following function: (1-(1/EXP(Beta*DELTAQ)))*Incidence*POP*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:

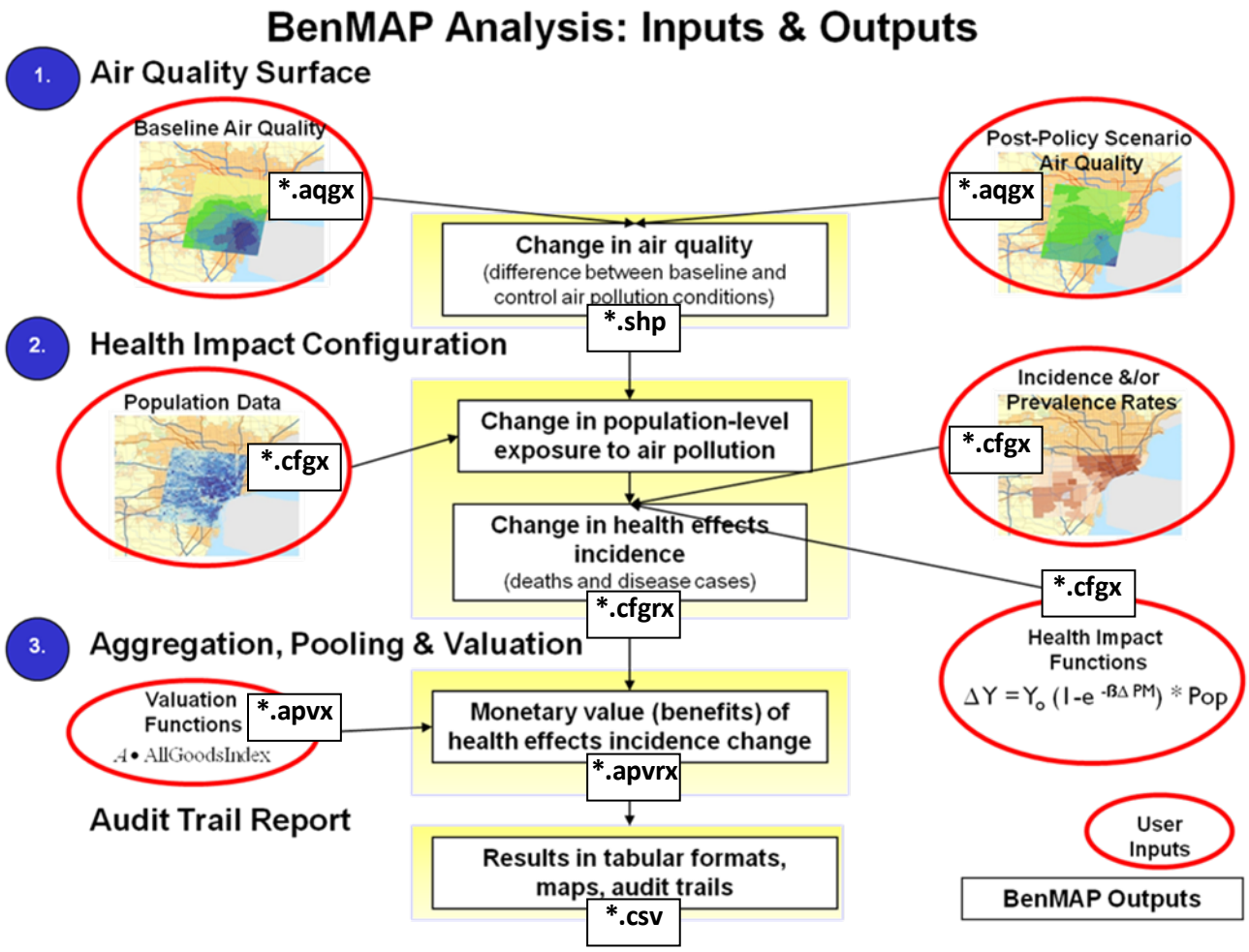


- Click *OK.* This will take you back to the *Health Impact Function Dataset Definition* window. Click *OK.*
- You should now see your health impact function in the *Manage Health Impact Function Datasets* window. Your function is now ready to use in an analysis.
- Click *OK* to return to the *Modify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

Likely 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
*.apvrx	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.

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 PM2.5 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.