BenMAP

Environmental Benefits Mapping and Analysis Program

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Air Benefits and Cost Group

Overview

- What is the BenMAP model?
- Data inputs to BenMAP
- Demonstration of model interface and outputs
- Analytical transparency in BenMAP
- Peer review results
- Use of BenMAP in Regulatory Impact Analyses
- Future directions for BenMAP development

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The BenMAP Model

A geographic information system-based program that:

- creates population level exposure surfaces
- estimates changes in incidence of a variety of health outcomes associated with changes in certain ambient air pollutants
- places a dollar value on changes in incidence of health outcomes

Key Features of BenMAP

- User-friendly experience
  - Driven by windows-based graphical user interface
  - Results (exposure, incidence, and valuation) available in a variety of formats including ASCII, .dbf, and shape files
- Comprehensiveness
  - Model includes a substantial population, health and air quality databases
  - Model incorporates an integrated GIS mapping, query, and statistics tool
- Flexibility
  - Enables users to perform a standardized or highly customized analysis
  - Users can add their own population, air quality, and health databases

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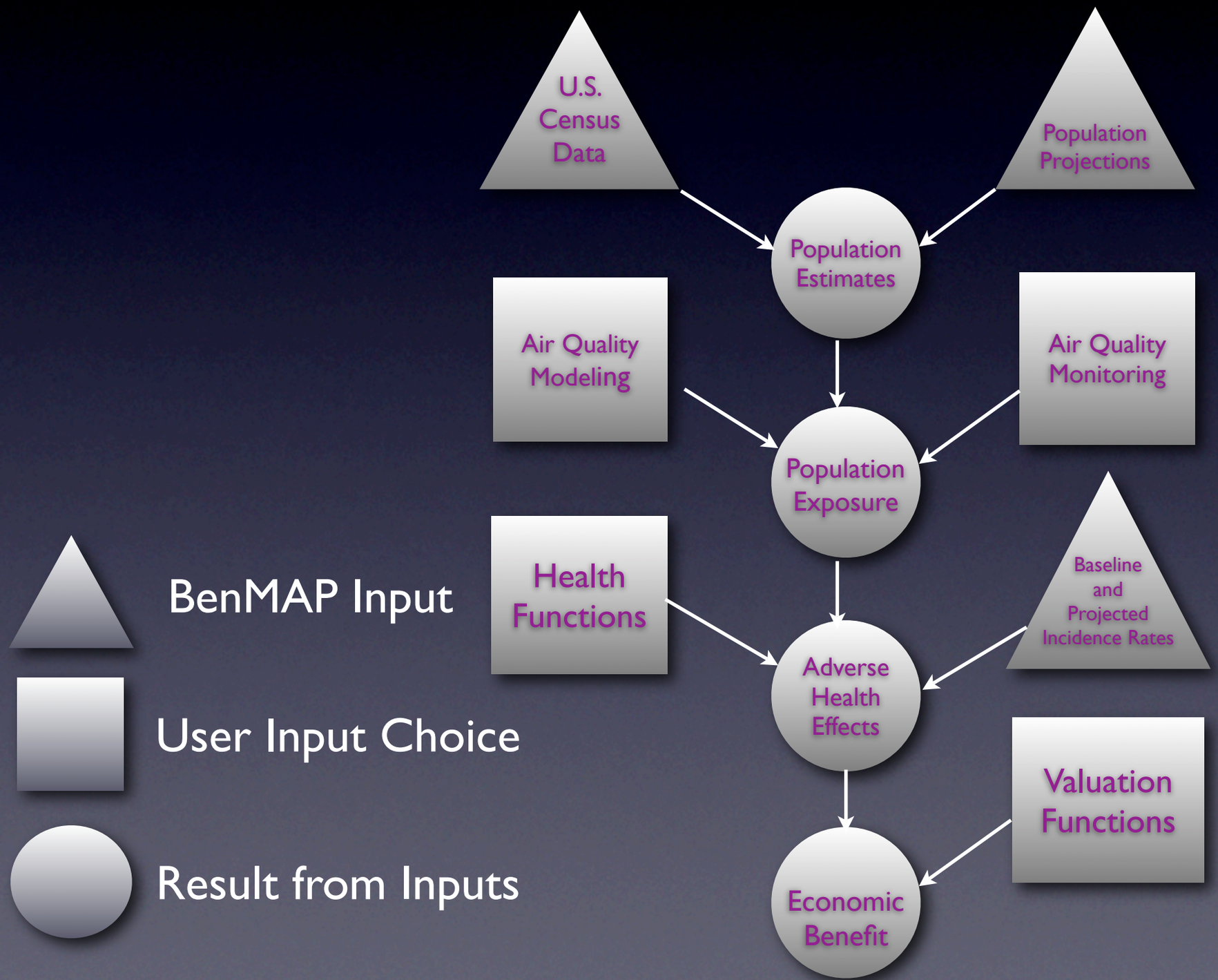
The Elements of a BenMAP Benefits Analysis



Options for Providing BenMAP with Air Quality Data

- Model accepts user-provided air quality data, both monitored and modeled
- Preloaded with:
  - AIRS data for ozone, PM_{10}, and $PM_{2.5}$ for a number of recent years (1996-2004)
  - Grid definitions corresponding to currently used EPA air quality models
- Provides several options for creating population exposure maps:
  - direct use of monitor or model data
  - use of model data with monitor data in a relative sense

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Options for Specifying Benefits Analysis

- Preloaded with hundreds of PM and Ozone concentration-response functions
  - Includes expert-elicitation derived $PM_{2.5}$ functions used in recent $PM_{2.5}$ Regulatory Impact Analysis
  - Users can easily add more C-R functions with the equation editor
- Model enables users to pool and aggregate incidence and valuation results
- Model estimates distributions of incidence and valuation results using Monte Carlo methods

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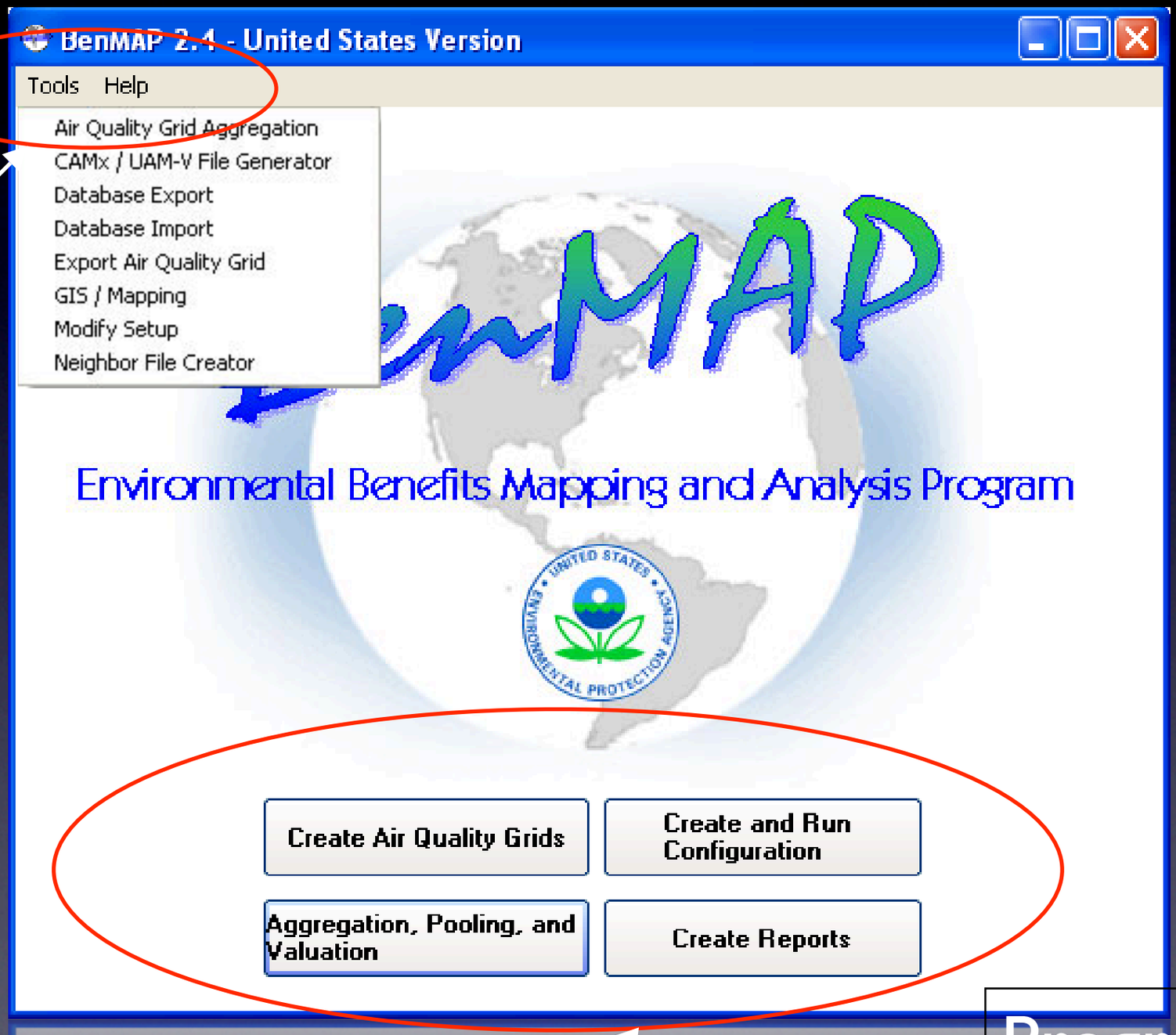
BenMAP Data Libraries

- Incidence rates (spatially variable)
  - A variety of incidence rate data covering numerous health effects
- Affected populations (spatially variable)
  - 2000 Census data and projections to 2025 for 250 age/sex/race population subgroups
- Estimated pollutant effect coefficients (represented by distributions)
  - Hundreds of concentration-response functions from the epidemiology literature
- Estimated/modeled changes in ambient air pollution (spatially variable)
  - BenMAP can estimate population level exposures based on modeled or monitored air quality, or a combination of both
- Estimated dollar values for avoided health effects (represented by distributions)
  - Hundreds of health effect-specific values

The BenMAP Interface



Data Entry and Utilities

Program Function Buttons

Alternative Ways to Analyze Air Quality Data

- Monitor Rollbacks
  - Useful for answering hypothetical questions like: "What if PM2.5 levels were reduced by 20 percent in Ohio?"
    - Available options include percentage reduction, absolute reduction, and rollback to standard
- Spatial and Temporal Scaling
  - Use a combination of modeling and monitoring data to project future air quality
- Monitor Direct
  - Import non-AIRS data into BenMAP

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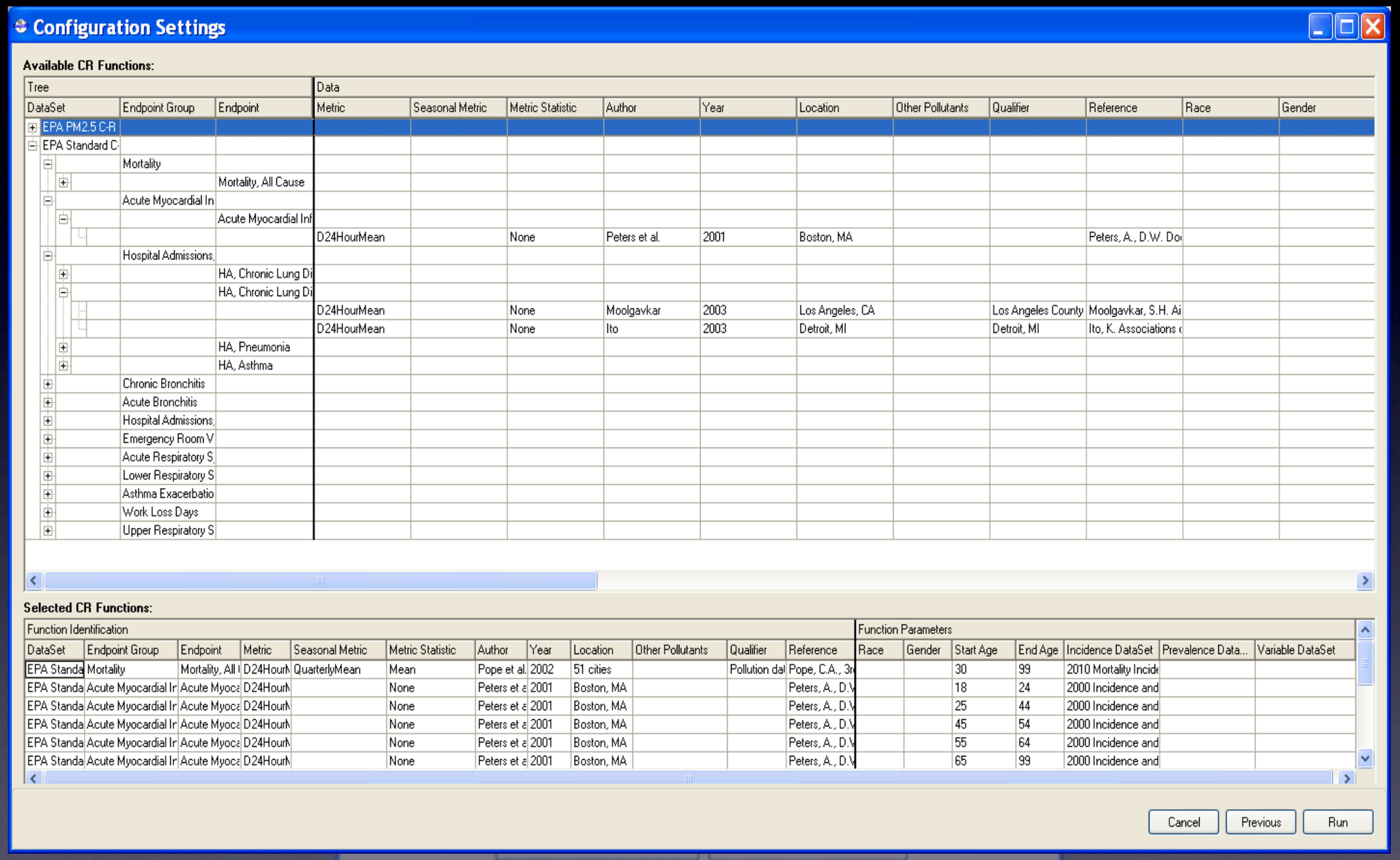
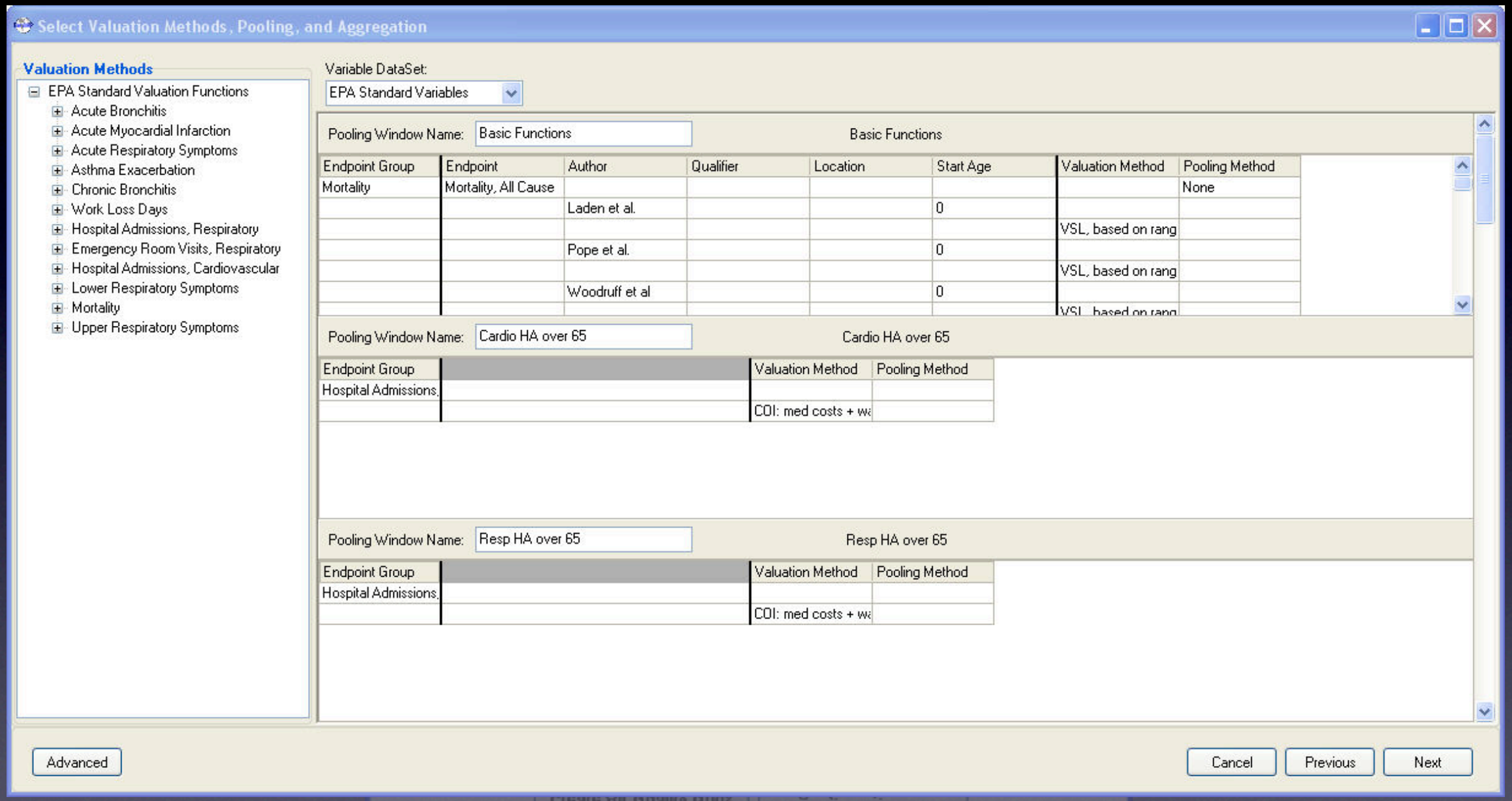
Step Two: Estimating Health Impacts



Step Three: Pooling, Aggregating, and Valuing Health Impacts



Outputs

- Users can export results to a number of formats:
  - ASCII files
  - Spreadsheets
  - GIS shape files
- Built-in GIS will display:
  - Gridded air quality data
  - Incidence and valuation estimates
- Users can print basic results information

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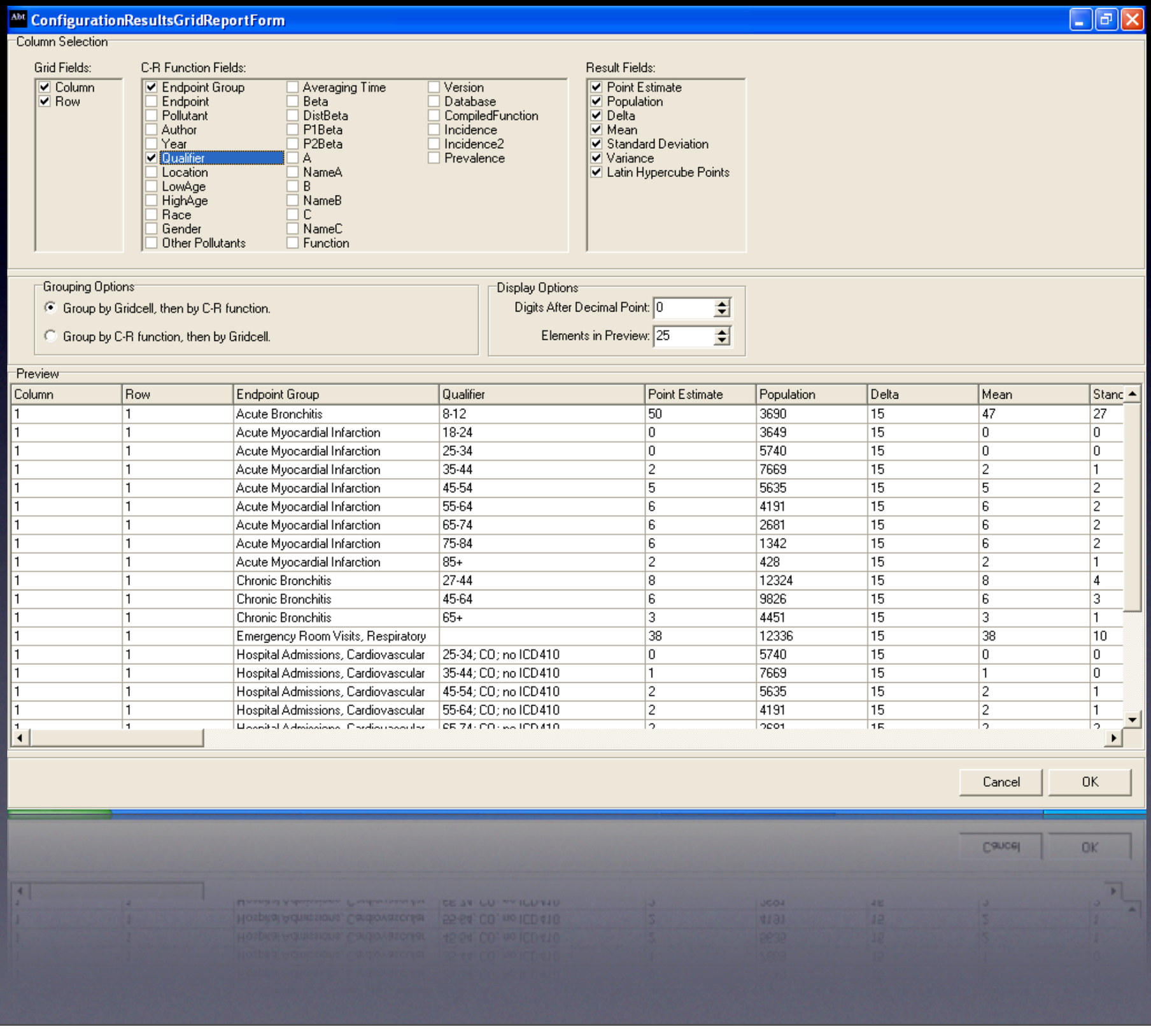
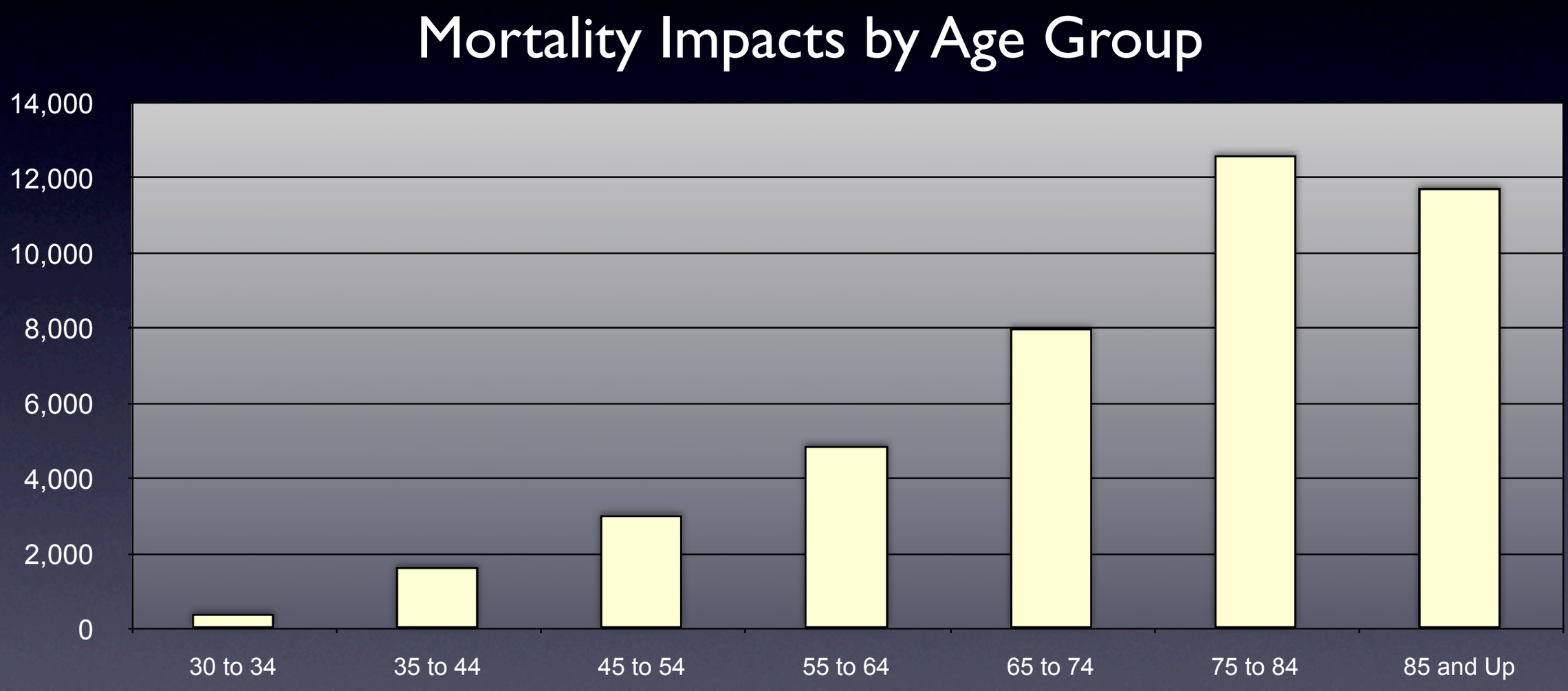
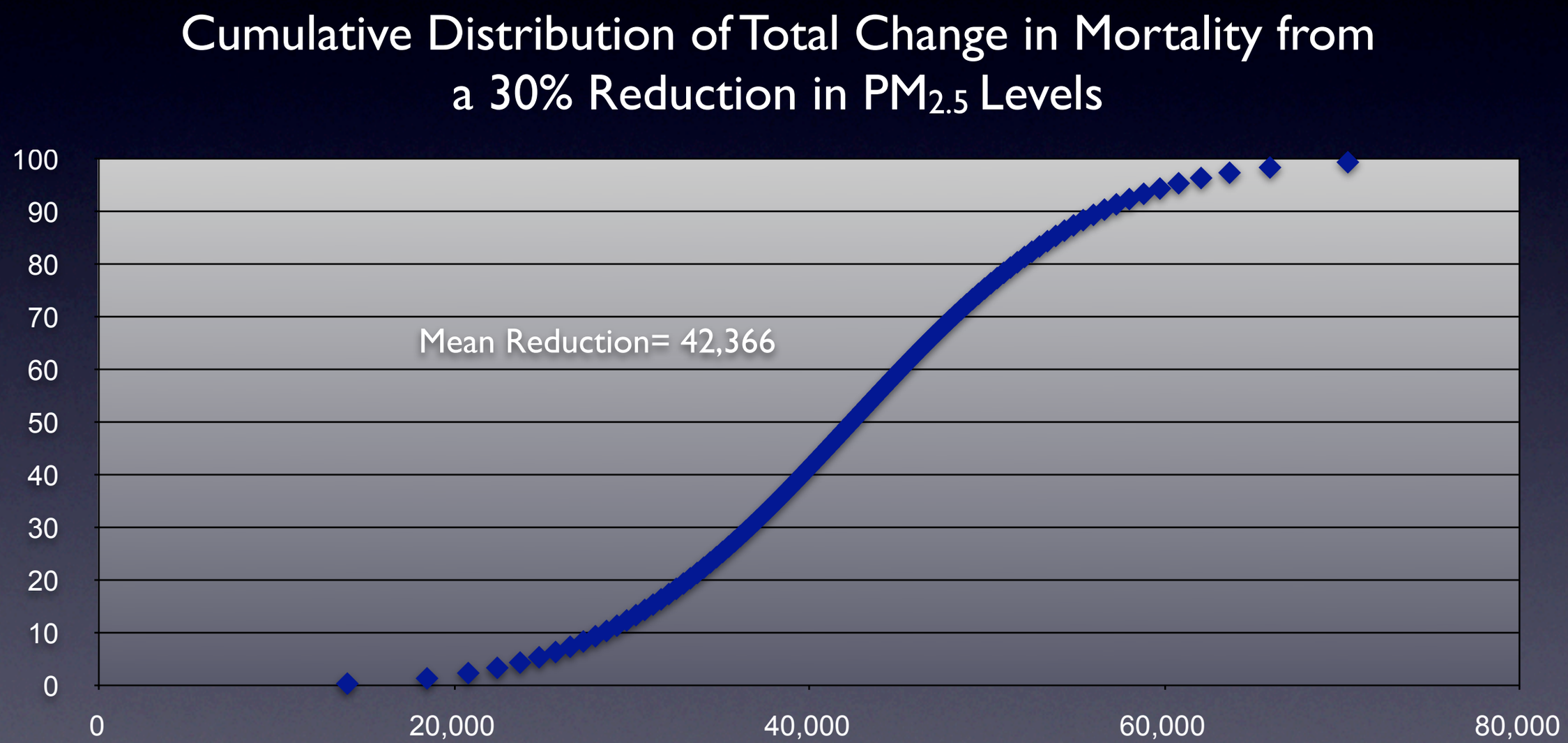
Report Generation



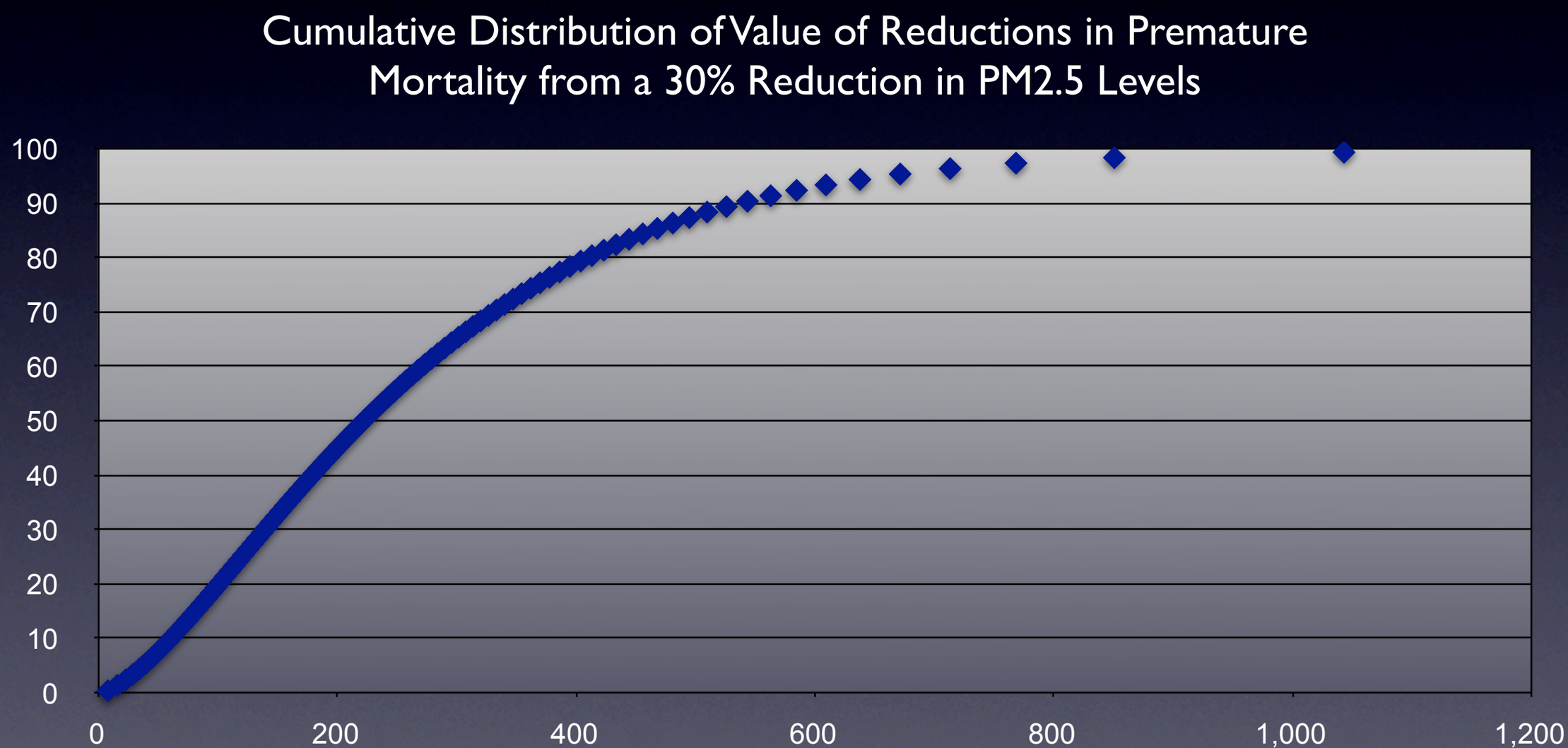
Examples of Graphs Produced Using BenMAP Outputs (1) Age Group Impacts



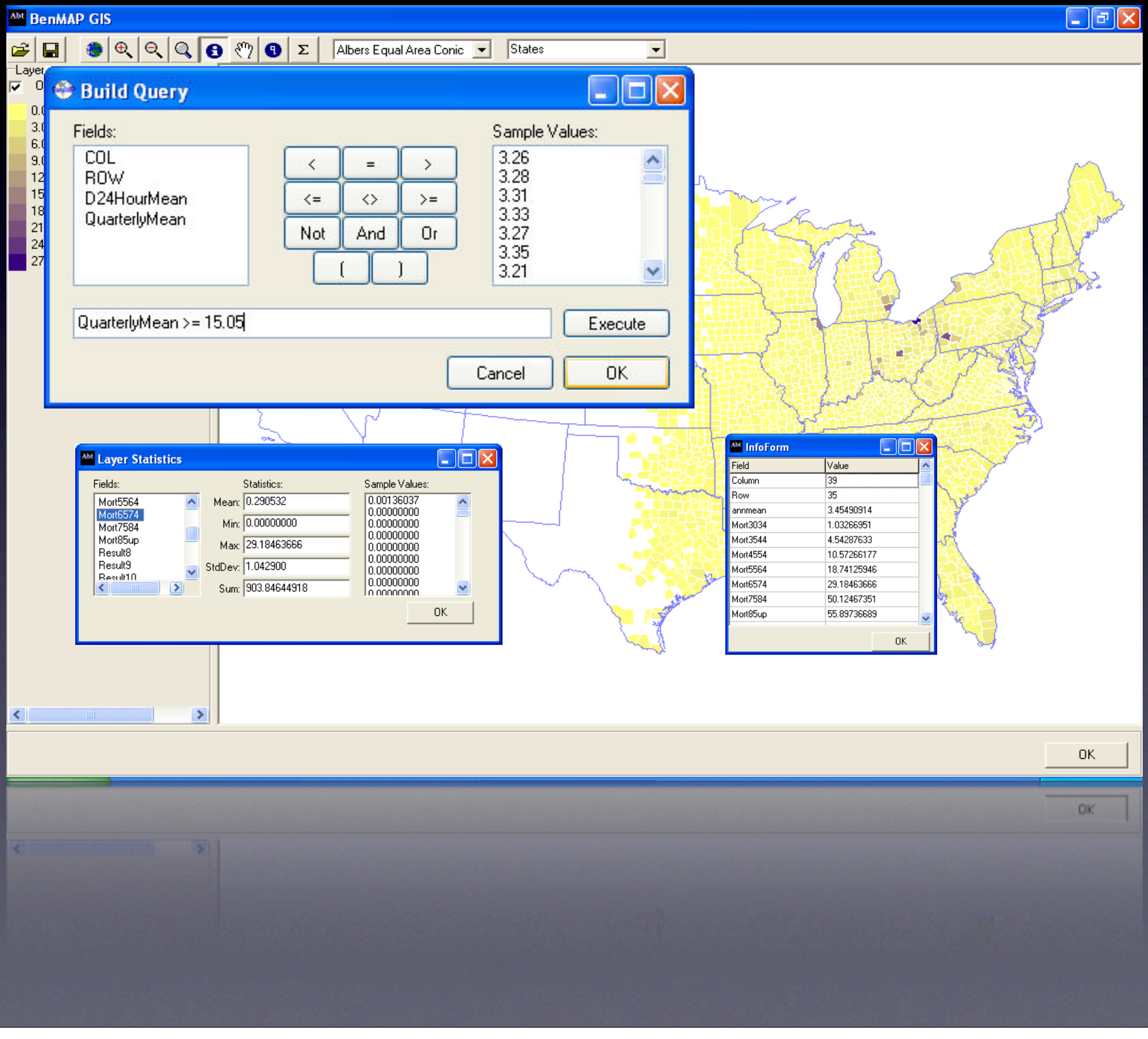
Examples of Graphs Produced Using BenMAP Outputs
(2) Distributions of Incidence



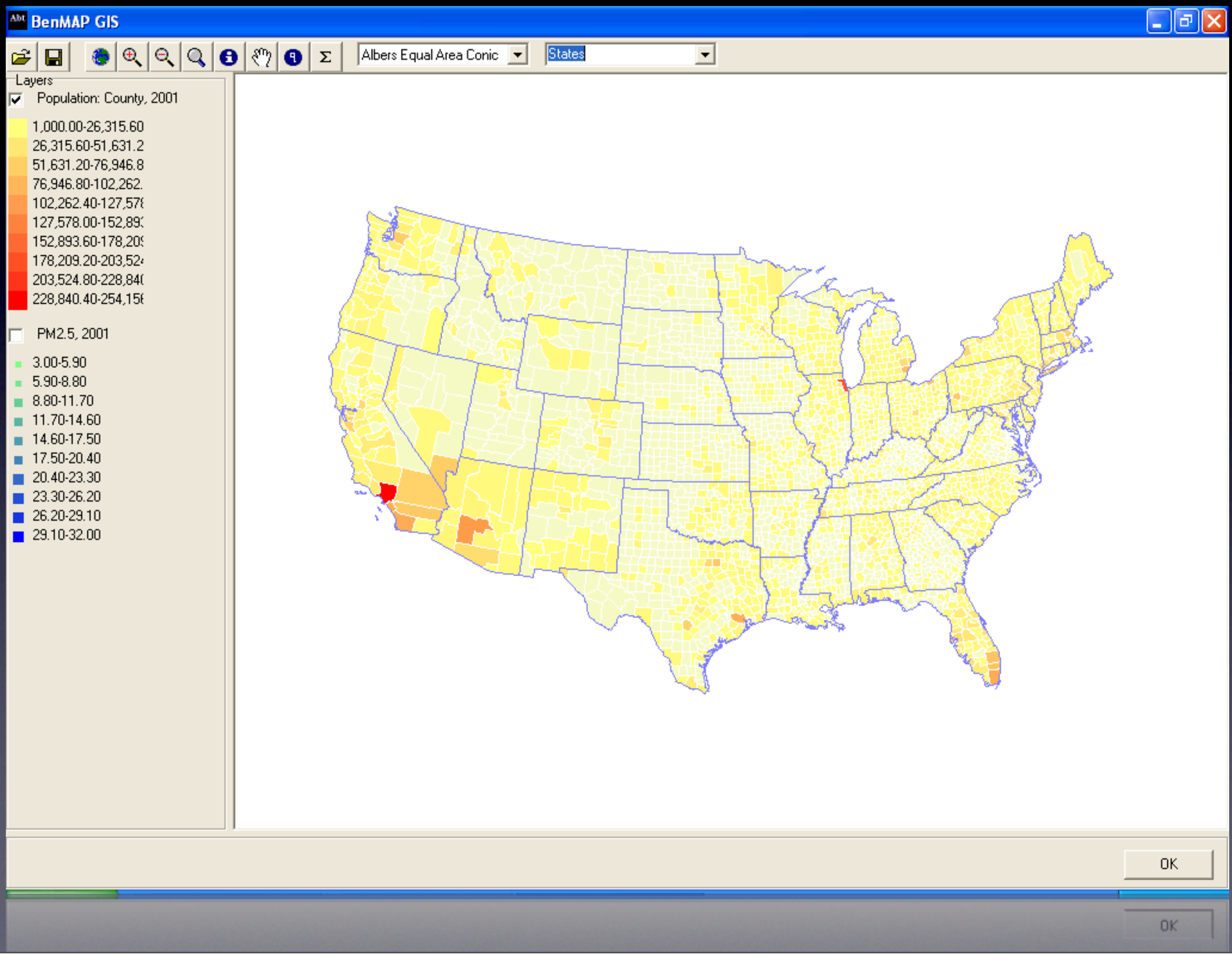
Examples of Graphs Produced Using BenMAP Outputs
(3) Distributions of Monetized Benefits



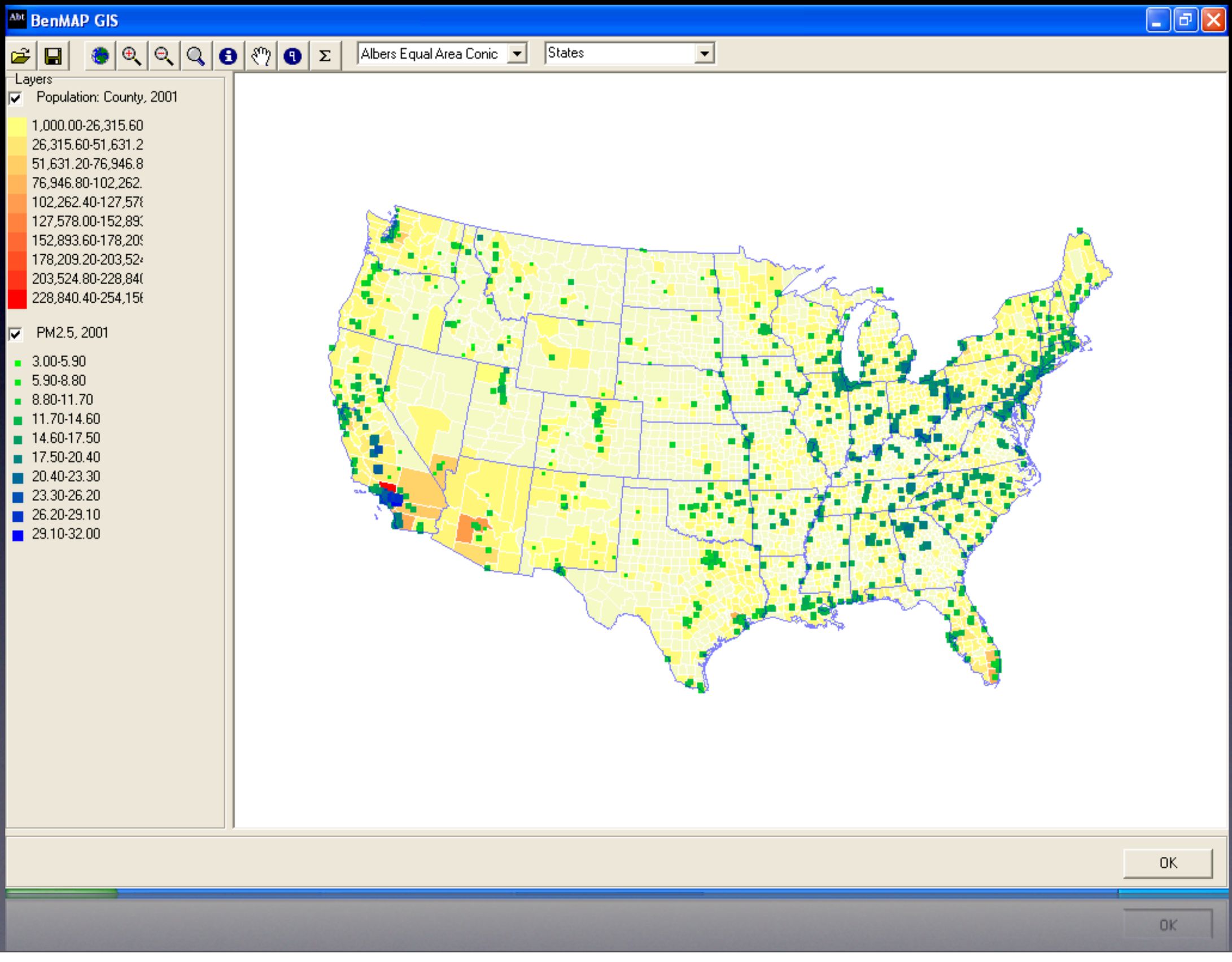
Example of Mapped Mortality Incidence Results



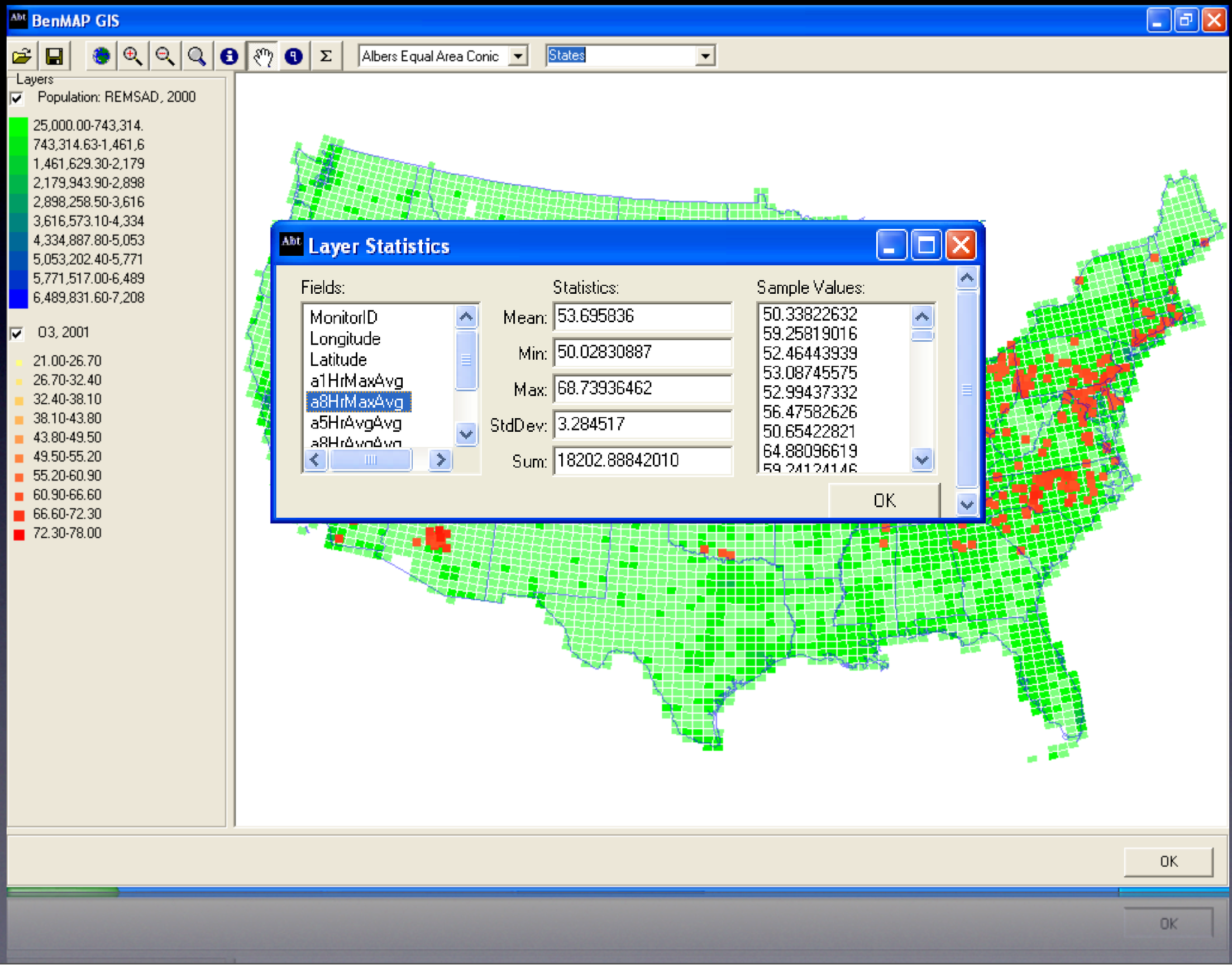
Map underlying population, air quality, and incidence rates



Overlay data from multiple sources



Query data and generate statistics



Analytical Transparency and Reproducibility

- BenMAP designed for public use and public scrutiny
- Published a detailed User's Guide with extensive appendices documenting model algorithms and data sources
- With each run, the user can generate an "audit trail" listing details of the run for QA and comparison with other analyses
- Consistent with Data Quality Guidelines, this "audit trail" can and should be shared with reviewers

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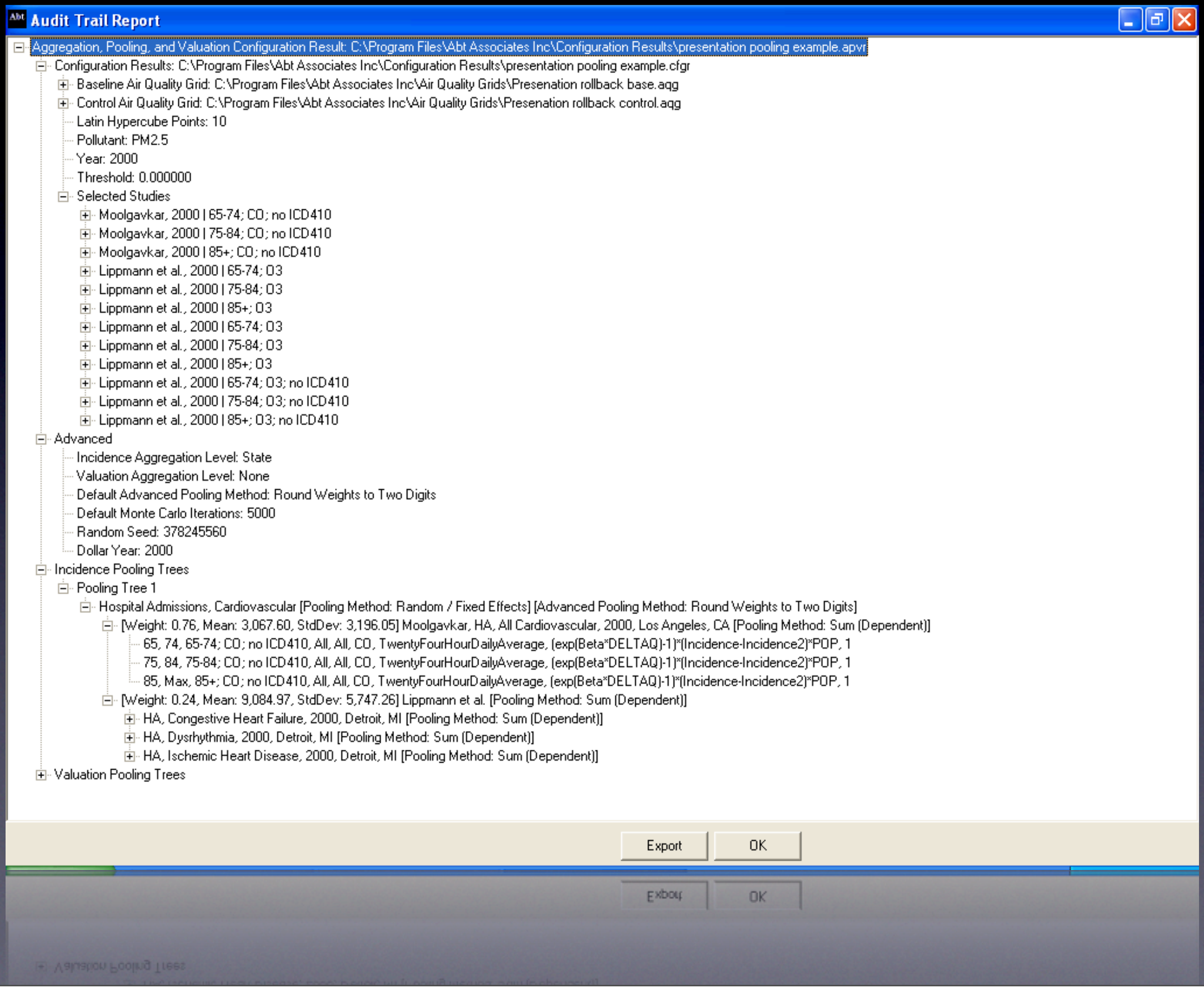
Audit Trail Report
Aggregation, Pooling, and Valuation Configuration Result: C:\Program Files\Abt Associates Inc\Configuration Results\presentation pooling example.apvr
Configuration Results: C:\Program Files\Abt Associates Inc\Configuration Results\presentation pooling example.cfgr
Baseline Air Quality Grid: C:\Program Files\Abt Associates Inc\Air Quality Grids\Presenation rollback base.aqg
Control Air Quality Grid: C:\Program Files\Abt Associates Inc\Air Quality Grids\Presenation rollback control.aqg
Latin Hypercube Points: 10
Pollutant: PM2.5
Year: 2000
Threshold: 0.000000
Selected Studies
Moolgavkar, 2000 | 65-74; CO; no ICD410
Moolgavkar, 2000 | 75-84; CO; no ICD410
Moolgavkar, 2000 | 85+; CO; no ICD410
Lippmann et al., 2000 | 65-74; O3
Lippmann et al., 2000 | 75-84; O3
Lippmann et al., 2000 | 85+; O3
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Lippmann et al., 2000 | 75-84; O3; no ICD410
Lippmann et al., 2000 | 85+; O3; no ICD410
Advanced
Incidence Aggregation Level: State
Valuation Aggregation Level: None
Default Advanced Pooling Method: Round Weights to Two Digits
Default Monte Carlo Iterations: 5000
Random Seed: 378245560
Dollar Year: 2000
Incidence Pooling Trees
Pooling Tree 1
Hospital Admissions, Cardiovascular [Pooling Method: Random / Fixed Effects] [Advanced Pooling Method: Round Weights to Two Digits]
[Weight: 0.76, Mean: 3,067.60, StdDev: 3,196.05] Moolgavkar, HA, All Cardiovascular, 2000, Los Angeles, CA [Pooling Method: Sum (Dependent)]
65, 74, 65-74; CO; no ICD410, All, All, CO, TwentyFourHourDailyAverage, (exp(Beta*DELTAQ)-1)*(Incidence-Incidence2)*POP, 1
75, 84, 75-84; CO; no ICD410, All, All, CO, TwentyFourHourDailyAverage, (exp(Beta*DELTAQ)-1)*(Incidence-Incidence2)*POP, 1
85, Max, 85+; CO; no ICD410, All, All, CO, TwentyFourHourDailyAverage, (exp(Beta*DELTAQ)-1)*(Incidence-Incidence2)*POP, 1
[Weight: 0.24, Mean: 9,084.97, StdDev: 5,747.26] Lippmann et al. [Pooling Method: Sum (Dependent)]
HA, Congestive Heart Failure, 2000, Detroit, MI [Pooling Method: Sum (Dependent)]
HA, Dysrhythmia, 2000, Detroit, MI [Pooling Method: Sum (Dependent)]
HA, Ischemic Heart Disease, 2000, Detroit, MI [Pooling Method: Sum (Dependent)]
Valuation Pooling Trees
Export
OK

Peer Review

- BenMAP was peer reviewed in the Spring of 2004.
  - Peer review available on the BenMAP website and included in all distribution CD's.
  - Peer review guidance followed to ensure independent, expert review
- Many peer review comments were addressed in version 2.3, released in 2005.

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New Features Added in Response to Comments

- Added more C-R and valuation functions
- Added mortality rate projections
- Enhanced documentation
- Enhanced accessibility of underlying databases
- Enhanced flexibility in adding new databases
- Addition of Quality Adjusted Life Years functions
- Addition of income adjustment factors (with uncertainty

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Use of BenMAP in Regulatory Impact Analyses

- Past RIA's:
  - Non-Road Diesel Rule
  - Clean Air Interstate Rule
  - $PM_{2.5}$ NAAQS
  - Small Spark Ignition Rule
  - Locomotive and Marine Diesel Rule
- Upcoming RIA's:
  - Ozone NAAQS
  - SO_2 NAAQS
  - NOx NAAQS

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Example International BenMAP Projects

- South Korea: Health benefits of Seoul air quality management plan
- Latin America: Benefits of air quality improvements in Mexico City, Saõ Paulo, Santiago
- India: Benefits analyses in Mumbai and Pune of alternate air quality policies

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Future Directions

- Adding new capabilities:
  - Assessing distributional impacts
  - Valuing reductions in exposures to air toxics
- Improving model interface
  - Creating wizard to enable users to perform a benefits analysis with default options
  - Refreshing user interface
  - Adding context-specific help
- Revising manual

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