

US EPA ARCHIVE DOCUMENT



Environmental Benefits Mapping and Analysis Program

David Risley

U.S. EPA, Office of Atmospheric Programs

Clean Air Markets Division

Overview

- Intro to Benefits and Mapping Analysis Program (BenMAP)
- Running BenMAP
- Generating BenMAP results
- Learn more about BenMAP

What is BenMAP and what can it do for you?

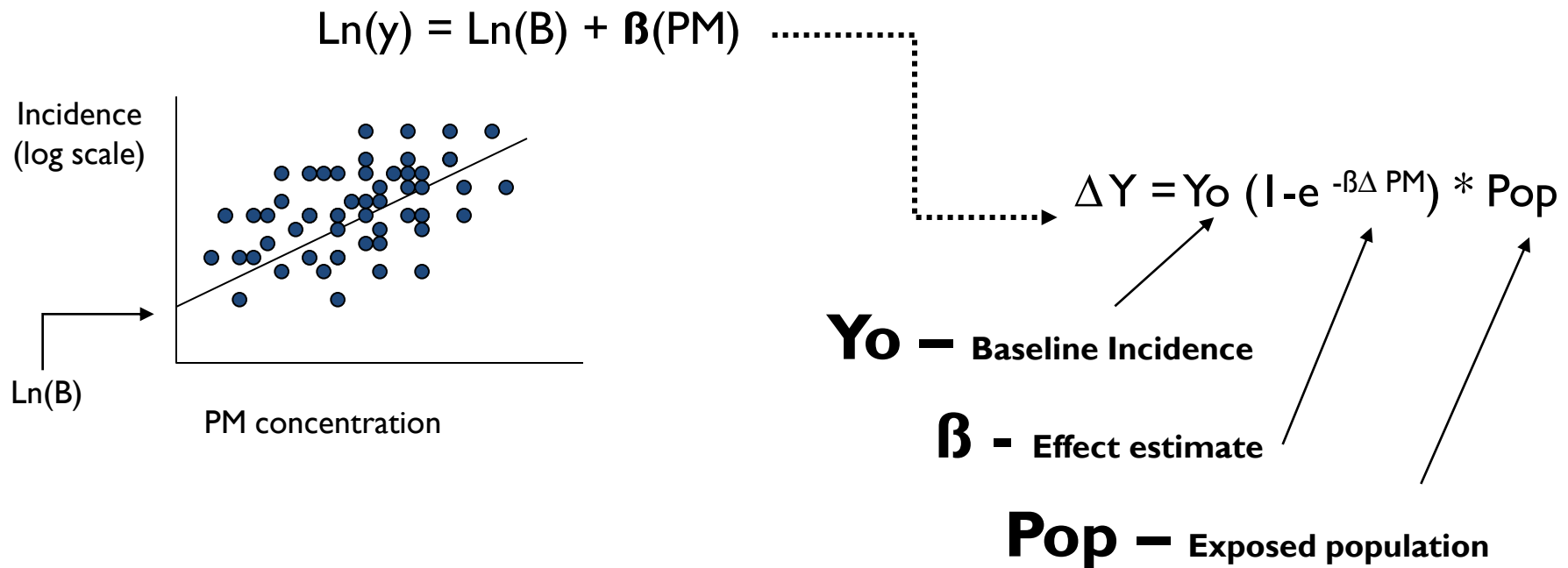
- BenMAP can estimate the health impacts (and associated economic value) of changes in air quality
- Simple tool for non-technical users
 - BenMAP includes nearly all the information users would need to perform a benefits analysis out of the box
- Complex tool for advanced users
 - BenMAP allows for complete customization for advanced or non-U.S. assessments
- BenMAP can estimate health impacts at any scale (city, regional, national, etc.)
- BenMAP's results can be mapped for ease of presentation

BenMAP has been used for:

- EPA rules
 - Clean Air Interstate Rule
 - PM2.5 and Ozone National Ambient Air Quality Standards
 - Small Spark Ignition Rule
 - Non-Road Diesel Rule and Locomotive and Marine Diesel Rule
- Other federal, state, and local assessments
 - FAA aircraft analysis
 - Washington and Oregon woodstove analyses
 - New York City Department of Health borough-level analysis
 - Georgia Department of Natural Resources SIP planning
- International assessments
 - China: Benefits analysis of EGU control strategy
 - South Korea: Health benefits of Seoul air quality management plan
 - Latin America: Benefits of air quality improvements in Mexico City, São Paulo, Santiago
 - India: Benefits analysis in Mumbai

How does BenMAP Estimate Health Benefits?

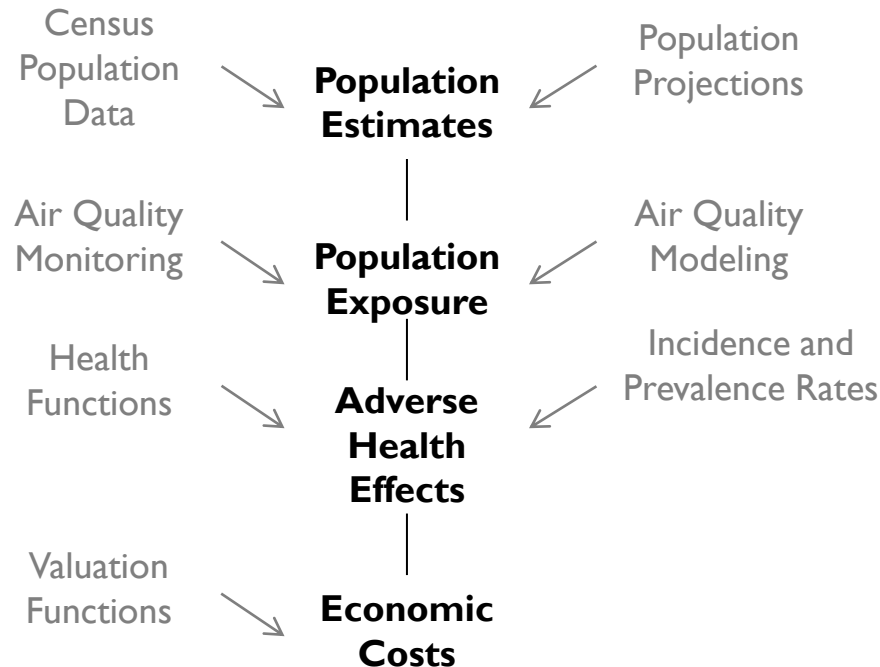
- Health Impact Functions
 - Epidemiology studies derive concentration-response functions relating pollutant concentrations and health outcomes



What Health Effects Does EPA Quantify?

<i>Health Endpoint</i>	<i>Particulate Matter</i>	<i>Ozone</i>
Mortality	✓	✓
Chronic bronchitis	✓	
Nonfatal heart attacks	✓	
Hospital admissions	✓	✓
Asthma ER visits	✓	✓
Acute respiratory symptoms	✓	✓
Asthma attacks	✓	✓
Work loss days	✓	
Worker productivity		✓
School absence rates		✓

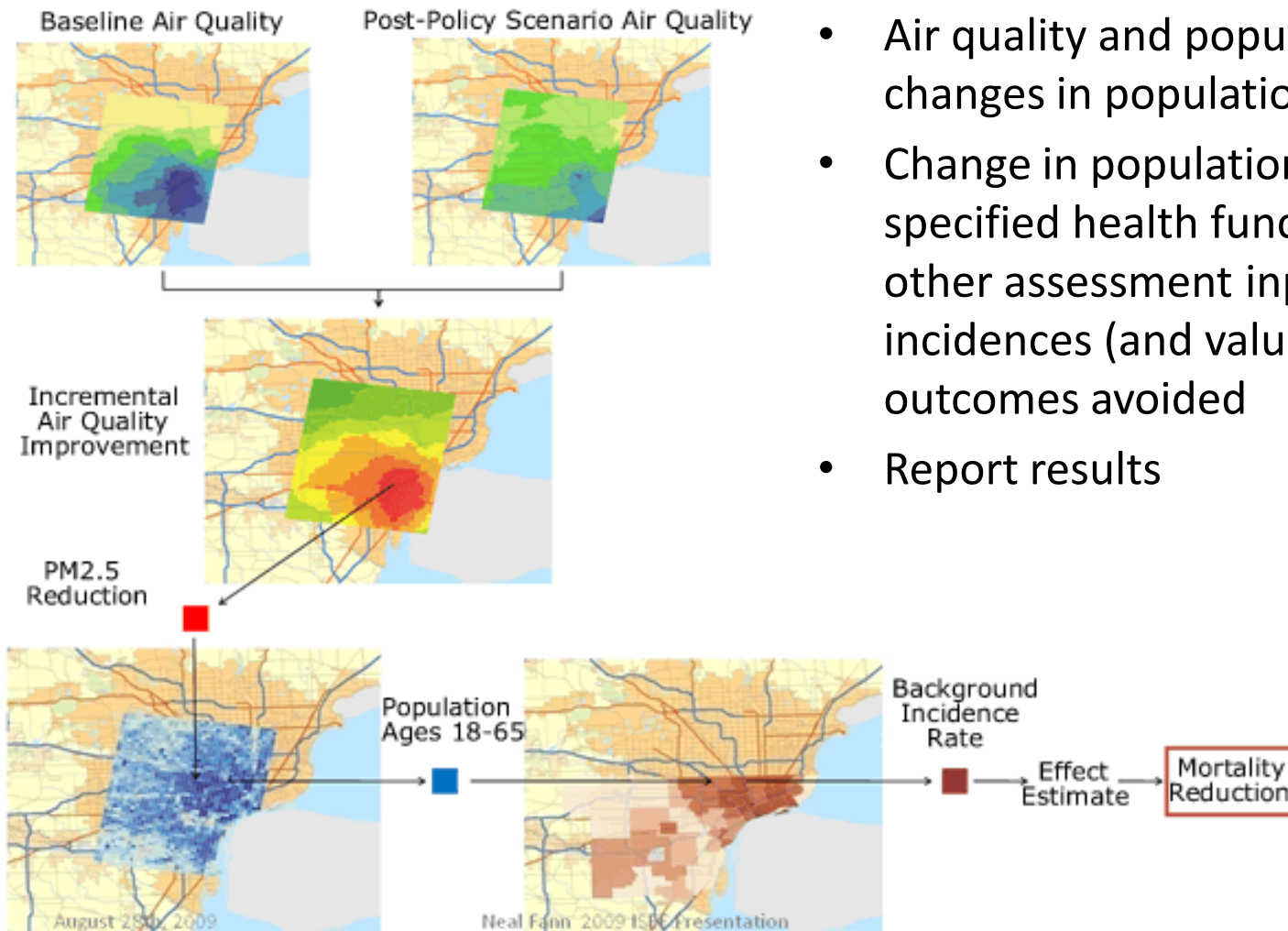
Data BenMAP Uses to Perform a Benefits Analysis



Gray text represents user specification or model input

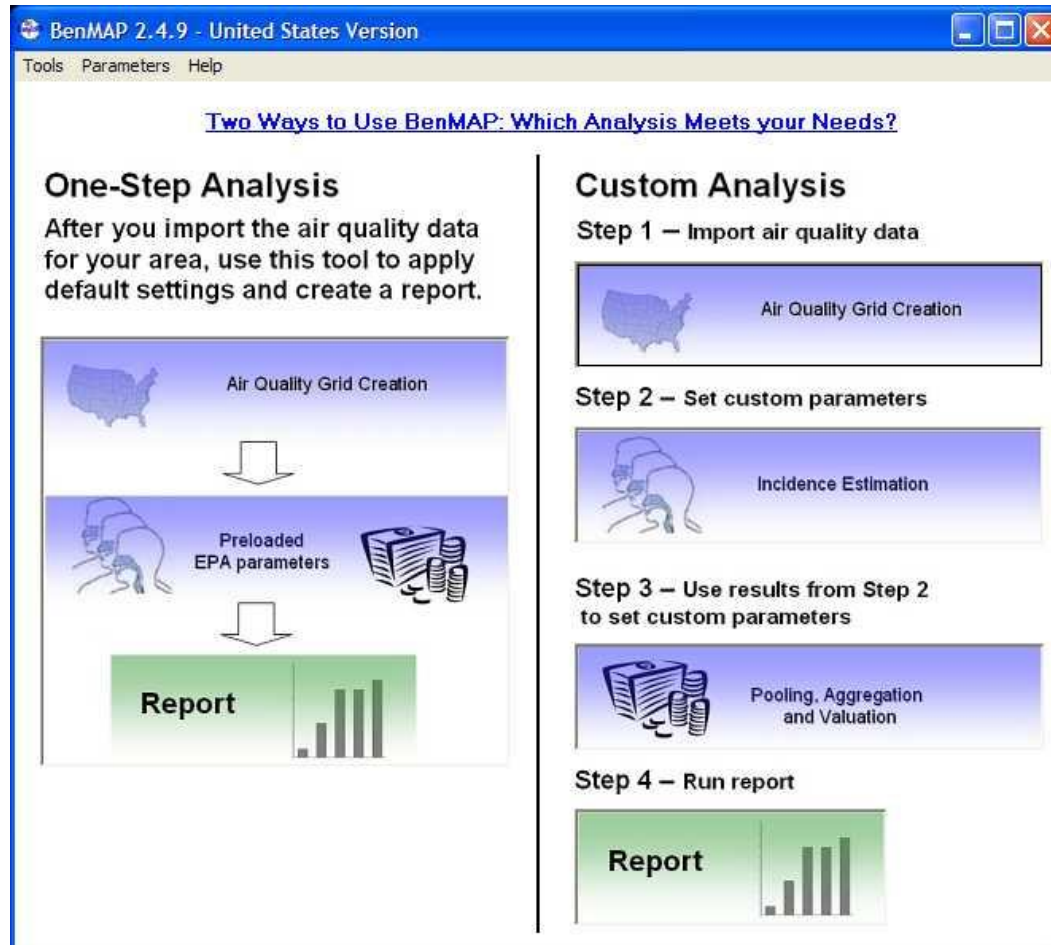
Black text represents result from inputs

How does BenMAP Estimate Health Benefits?



- Air quality and population data → changes in population exposure
- Change in population exposure; specified health functions; and other assessment inputs → incidences (and value) of health outcomes avoided
- Report results

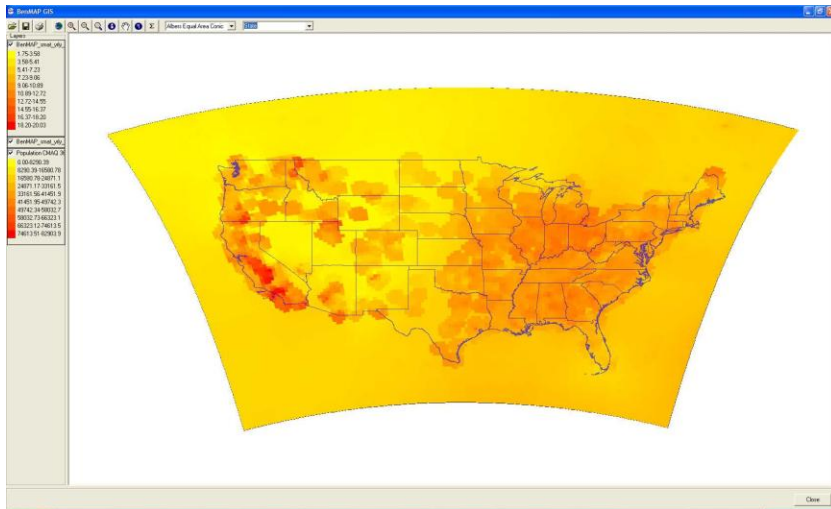
BenMAP Interface



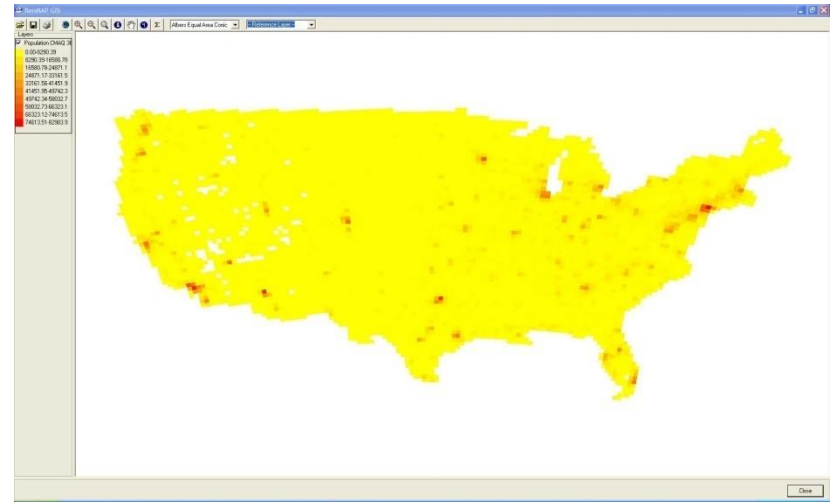
Air Quality Data

- Goal: Estimate change in population exposure to pollutant of interest
- Monitored air quality data
 - BenMAP includes built-in monitoring data
 - AIRS data for ozone, PM₁₀, and PM_{2.5}
 - Import monitoring data from other sources
- Modeled air quality data
 - Easy to import modeling data
 - Import data from other modeling platforms

Specifying Air Quality Data and Calculating Changes in Exposure



Air Quality Distribution



Population Distribution

Specifying the Benefits Analysis Options

- Select health impact and valuation functions
 - BenMAP is pre-loaded with hundreds of PM_{2.5} and ozone health impact functions
 - Users can add import additional functions
- Choose an analysis year
- Value the results
 - BenMAP allows you place an economic value on incidences of health impacts avoided
- Aggregate the results
 - BenMAP allows you to aggregate and pool the incidence estimates and economic values

Specifying the Benefits Analysis Options

Configuration Settings

Available CR Functions:

Tree	DataSet	Endpoint Group	Endpoint	Data	Metric	Seasonal Metric	Metric Statistic	Author	Year
+	Complete BenM4								
+	CRFunctionData								
+	Detroit Test Fun								

Function Identification

DataSet	Endpoint Group	Endpoint	Metric	Seasonal Metric	Metric Statistic	Author	Year	Location	Other Pollutants
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Laden et al	2006	6 cities	
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Pope et al	2002	51 cities	
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Pope et al	2002	51 cities	
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Pope et al	2002	51 cities	
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Pope et al	2002	51 cities	
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Pope et al	2002	51 cities	
Alternative N	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Woodruff et al	2006	204 counties	
EPA Standa	Chronic Bronchitis	Chronic Bron	D24Hour	QuarterlyMean	Mean	Abbey et al	1995	SF, SD, Sou	
EPA PM2.5	Chronic Bronchitis	Chronic Bron	D24Hour	QuarterlyMean	Mean	Abbey et al	1995	SF, SD, Sou	
EPA PM2.5	Acute Bronchitis	Acute Bronch	D24Hour	QuarterlyMean	Mean	Dockery et al	1996	24 communit	
EPA PM2.5	Acute Myocardial In	Acute Myocard	D24Hour		None	Peters et al	2001	Boston, MA	
EPA PM2.5	Acute Myocardial In	Acute Myocard	D24Hour		None	Peters et al	2001	Boston, MA	
EPA PM2.5	Acute Myocardial In	Acute Myocard	D24Hour		None	Peters et al	2001	Boston, MA	
EPA PM2.5	Acute Myocardial In	Acute Myocard	D24Hour		None	Peters et al	2001	Boston, MA	
EPA PM2.5	Acute Myocardial In	Acute Myocard	D24Hour		None	Peters et al	2001	Boston, MA	
EPA PM2.5	Hospital Admissions HA, Chronic		D24Hour		None	Moolgavkar, S	2003	Los Angeles	
EPA PM2.5	Hospital Admissions HA, Chronic		D24Hour		None	Ito	2003	Detroit, MI	
EPA PM2.5	Hospital Admissions HA, Chronic		D24Hour		None	Moolgavkar, S	2000	Los Angeles	
EPA PM2.5	Hospital Admissions HA, Pneumo		D24Hour		None	Ito	2003	Detroit, MI	
EPA PM2.5	Hospital Admissions HA, Asthma		D24Hour		None	Sheppard	2003	Seattle, WA	
EPA PM2.5	Hospital Admissions HA, All Cardi		D24Hour		None	Moolgavkar, S	2003	Los Angeles	
EPA PM2.5	Hospital Admissions HA, All Cardi		D24Hour		None	Moolgavkar, S	2000	Los Angeles	
EPA PM2.5	Hospital Admissions HA, Ischemic		D24Hour		None	Ito	2003	Detroit, MI	
EPA PM2.5	Hospital Admissions HA, Dysrhyth		D24Hour		None	Ito	2003	Detroit, MI	
EPA PM2.5	Hospital Admissions HA, Congest		D24Hour		None	Ito	2003	Detroit, MI	
EPA PM2.5	Emergency Room V	Emergency F	D24Hour		None	Norris et al	1999	Seattle, WA	NO2, SO2
EPA PM2.5	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Woodruff et al	1997	86 cities	
EPA PM2.5	Acute Respiratory S	Minor Restrict	D24Hour		None	Ostro et al	1989	Nationwide	Ozone
EPA PM2.5	Lower Respiratory S	Lower Respi	D24Hour		None	Schwartz et al	2000	6 U.S. cities	
EPA PM2.5	Asthma Exacerbatic	Asthma Exac	D24Hour		None	Ostro et al	2001	Los Angeles	
EPA PM2.5	Asthma Exacerbatic	Asthma Exac	D24Hour		None	Vedal et al	1998	Vancouver, I	
EPA PM2.5	Asthma Exacerbatic	Asthma Exac	D24Hour		None	Ostro et al	2001	Los Angeles	
EPA PM2.5	Asthma Exacerbatic	Asthma Exac	D24Hour		None	Ostro et al	2001	Los Angeles	
EPA PM2.5	Work Loss Days	Work Loss D	D24Hour		None	Ostro	1987	Nationwide	
EPA PM2.5	Upper Respiratory S	Upper Respi	D24Hour		None	Pope et al	1991	Utah Valley	
Expert Elicit	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Expert A	2006		
Expert Elicit	Mortality	Mortality, All	D24Hour	QuarterlyMean	Mean	Expert B	2006		

Configuration Settings

Select Air Quality Grids:

Baseline File:

Control File:

Settings

Latin Hypercube Points:

Population Data Set:

Population Year:

Run In Point Mode:
☐

Threshold:

Los Angeles	Moolgavkar, S	65	99	2000 Incidence and				
Los Angeles	Moolgavkar, S	18	64	2000 Incidence and				
Detroit, MI	Ito, K, Associa	65	99	2000 Incidence and				
Detroit, MI	Ito, K, Associa	65	99	2000 Incidence and				
Detroit, MI	Ito, K, Associa	65	99	2000 Incidence and				
Seattle, WA	Norris, G., et al	0	17	2000 Incidence and				
Infant Mort	Woodruff, T.J.,	0	0	2020 Mortality Incide				
Ostro, B.D. and		18	64					
Schwartz, J. et al		7	14					
African-Ame	Ostro, B., M. Li	6	18					
Pollutant list	Vedal, S., et al	6	18					
African-Ame	Ostro, B., M. Li	6	18					
African-Ame	Ostro, B., M. Li	6	18					
Pollutant list	Ostro, B.D. Air	18	64	2000 Incidence and				
Full Range	Pope, C.A., et	9	11					
BenMAP 2.4		30	99	2020 Mortality Incide				
BenMAP 2.4		20	60	2020 Mortality Incide				

Reporting the Results

APV Configuration Results Report

File

Column Selection

Grid Fields:

☐ Column
☐ Row

Pooled Valuation Method Fields:

☒ Endpoint Group
☒ Start Age
☒ Author
☐ Endpoint
☐ Pooling Window
☐ Qualifier
☐ Location

Result Fields:

☒ Point Estimate
☒ Mean
☒ Standard Deviation
☒ Variance
☒ Latin Hypercube Points

Add Sums

Grouping Options

☒ Group by Gridcell, then by Pooled Valuation Method.
☐ Group by Pooled Valuation Method, then by Gridcell.

Display Options

Digits After Decimal Point:
Elements in Preview:

Preview

Endpoint Group	Start Age	Author	Point Estimate	Mean	Standard Deviation	Variance	Percentile 0.5	Percentile 1.5	Percentile 2.5	Percentile 3.5	Percentile 4.5	Percentile 5.5	Percentile 6.5	Percentile 7.5	Percentile 8.5	Percentile 9.5
Mortality	25		62,761,504,768	62,714,671,104	31,262,892,032	9,773,683,763,821,788	4,724,240,384	5,905,928,704	10,087,804,928	13,584,701,440	16,333,523,968	18,284,507,136	20,265,000,960	21,850,322,944	23,320,436,736	24,773,115,712
Mortality	30		27,557,281,792	27,535,820,800	15,347,742,720	2,355,532,138,696,156	-2,074,318,848	2,348,057,856	3,862,346,496	5,087,364,608	6,126,331,904	6,907,295,744	7,670,400,000	8,236,463,616	8,787,537,920	9,354,016,704
Mortality	0	Woodruff et al.	90,529,712	90,313,144	103,571,488	1,072,705,233,643,116	-113,420,712	-96,301,616	-86,141,704	-78,026,720	-70,740,384	-63,688,112	-56,401,784	-48,286,796	-38,126,888	-21,007,784
Mortality	0	Woodruff et al.	48,539,360	48,496,620	25,170,120	633,534,922,358,788	-3,653,710	4,348,858	7,370,628	10,002,926	11,962,030	13,485,016	14,862,221	16,057,430	17,170,762	18,322,694
Chronic Bronchitis			912,007,168	904,675,776	1,109,483,520	1,230,953,707,391,168	23,797,058	39,017,660	51,335,176	60,970,756	70,613,272	78,916,384	89,633,784	98,178,240	105,592,880	115,542,256
Acute Myocardial Inf			44,258,176	44,236,720	11,527,145	132,875,064,180,73	23,977,826	23,977,826	23,977,826	23,977,826	23,977,826	23,977,826	23,977,826	23,977,826	23,977,826	23,977,826
Hospital Admissions			575,504,960	575,285,312	240,848,288	5,800,790,314,222,11	247,748,752	247,748,752	247,748,752	247,748,752	247,748,752	253,098,192	258,447,632	258,447,632	258,447,632	258,447,632
Hospital Admissions			4,896,972	4,915,275	1,947,970	3,794,585,780,224	2,461,463	2,461,463	2,461,463	2,461,463	2,461,463	2,461,463	2,461,463	2,461,463	2,461,463	2,461,463
Emergency Room Vi			17,281,488	17,281,224	3,529,582	12,457,945,858,048	11,091,090	11,091,090	11,091,090	11,091,090	11,091,090	11,091,090	11,091,090	11,091,090	11,091,090	11,091,090
Acute Bronchitis			6,476,168	6,474,858	4,925,038	24,255,999,770,624	-2,164,562	-2,164,562	-2,164,562	-2,164,562	-2,164,562	-2,164,562	-2,164,562	-2,164,562	-2,164,562	-2,164,562
Lower Respiratory S			1,990,386	1,988,975	3,031,827	9,191,974,502,400	-3,330,663	-3,330,663	-3,330,663	-3,330,663	-3,330,663	-3,330,663	-3,330,663	-3,330,663	-3,330,663	-3,330,663
Upper Respiratory S			7,852,826	7,851,914	3,091,966	9,560,252,219,392	2,427,850	2,427,850	2,427,850	2,427,850	2,427,850	2,427,850	2,427,850	2,427,850	2,427,850	2,427,850
Acute Respiratory S			8,720,892	8,720,742	2,011,610	4,046,573,535,232	5,192,807	5,192,807	5,192,807	5,192,807	5,192,807	5,192,807	5,192,807	5,192,807	5,192,807	5,192,807
Work Loss Days			701,282	701,043	191,827	36,797,624,320	332,668	352,662	366,692	380,772	395,321	408,600	420,684	432,116	442,895	452,057
Asthma Exacerbation			586,746	586,608	138,021	19,049,678,848	333,751	337,972	340,477	342,478	344,275	346,013	347,810	349,811	352,316	356,537
Acute Myocardial Inf																
Acute Myocardial Inf			42,383,828	42,363,280	11,038,981	121,859,110,600,70	22,962,340	22,962,340	22,962,340	22,962,340	22,962,340	22,962,340	22,962,340	22,962,340	22,962,340	22,962,340
Mortality		Pope et al.	24,481,386,496	24,463,034,368	13,631,747,072	1,858,245,371,529,348	-1,842,788,608	2,086,079,744	3,433,086,976	4,521,929,728	5,445,429,248	6,139,299,328	6,817,083,392	7,320,991,744	7,808,094,208	8,314,332,608
Mortality		Pope et al.	24,481,386,496	24,463,034,368	13,631,747,072	1,858,245,371,529,348	-1,842,788,608	2,086,079,744	3,433,086,976	4,521,929,728	5,445,429,248	6,139,299,328	6,817,083,392	7,320,991,744	7,808,094,208	8,314,332,608
Mortality		Pope et al.	30,619,193,344	30,594,951,168	17,050,534,912	2,907,207,260,081,598	-2,304,796,672	2,609,030,144	4,292,405,248	5,653,813,248	6,808,467,456	7,676,220,416	8,523,904,000	9,153,533,952	9,764,748,288	10,395,518,016
Mortality		Pope et al.	34,434,789,376	34,406,346,752	19,181,977,600	3,679,482,413,120,768	-2,592,005,376	2,933,902,848	4,823,172,096	6,352,982,016	7,650,407,424	8,626,140,160	9,579,837,440	10,285,555,712	10,978,416,640	11,681,134,016
Mortality		Expert L	34,240,378,880	35,542,274,048	27,101,196,288	7,344,748,932,542,756	-2,710,941,440	1,349,971,840	2,247,942,656	2,795,686,400	3,227,941,888	3,664,583,680	3,994,093,056	4,361,769,984	4,644,871,680	4,988,466,176
Mortality		Expert K	8,152,312,832	8,133,760,640	14,370,235,392	2,065,036,532,669,368	0	0	0	0	0	0	0	0	0	0
Mortality		Expert J	40,302,100,480	45,717,766,144	30,649,223,168	9,393,748,840,257,748	-3,271,746,048	3,078,290,944	5,122,287,104	6,590,563,328	7,753,504,768	8,508,133,888	9,602,084,864	10,314,596,352	11,149,133,824	11,807,995,200
Mortality		Expert I	49,822,646,272	51,609,178,112	32,166,174,720	1,034,662,274,662,912	-3,947,664,384	2,707,643,904	4,210,218,752	5,272,602,624	6,112,449,024	6,852,568,576	7,531,906,560	8,282,207,232	8,962,666,496	9,689,190,400

14

Done

Learn more about BenMAP

- Visit the BenMAP website for more information:
<http://www.epa.gov/airquality/benmap>
 - Training materials
 - Presentations
- Two providers of BenMAP Training:
 - Abt Associates Inc.
 - Community Modeling Analysis System