US EPA ARCHIVE DOCUMENT

BenMAP

Environmental Benefits Mapping and Analysis Program

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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 <u>changes in air quality</u>
- 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

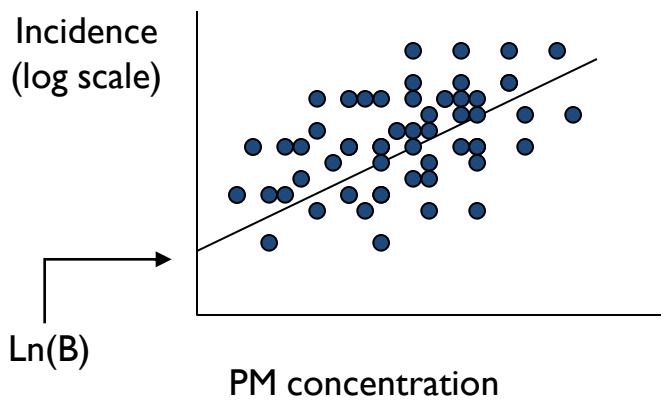
BenMAP has been used for:

- 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, Saõ 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

$$Ln(y) = Ln(B) + \beta(PM)$$



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

Yo – Baseline Incidence

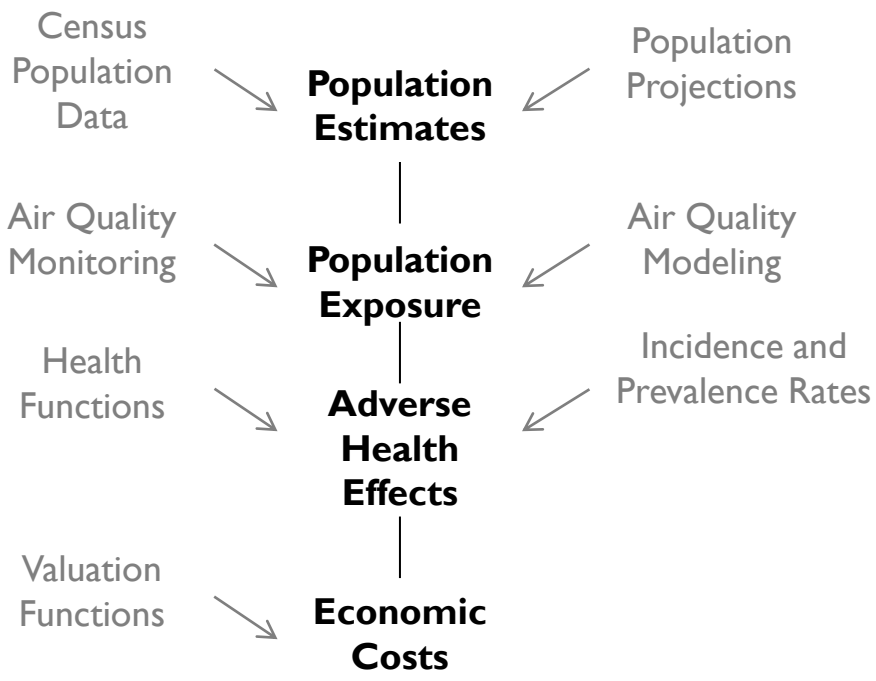
ß - Effect estimate

Pop – Exposed population

What Health Effects Does EPA Quantify?

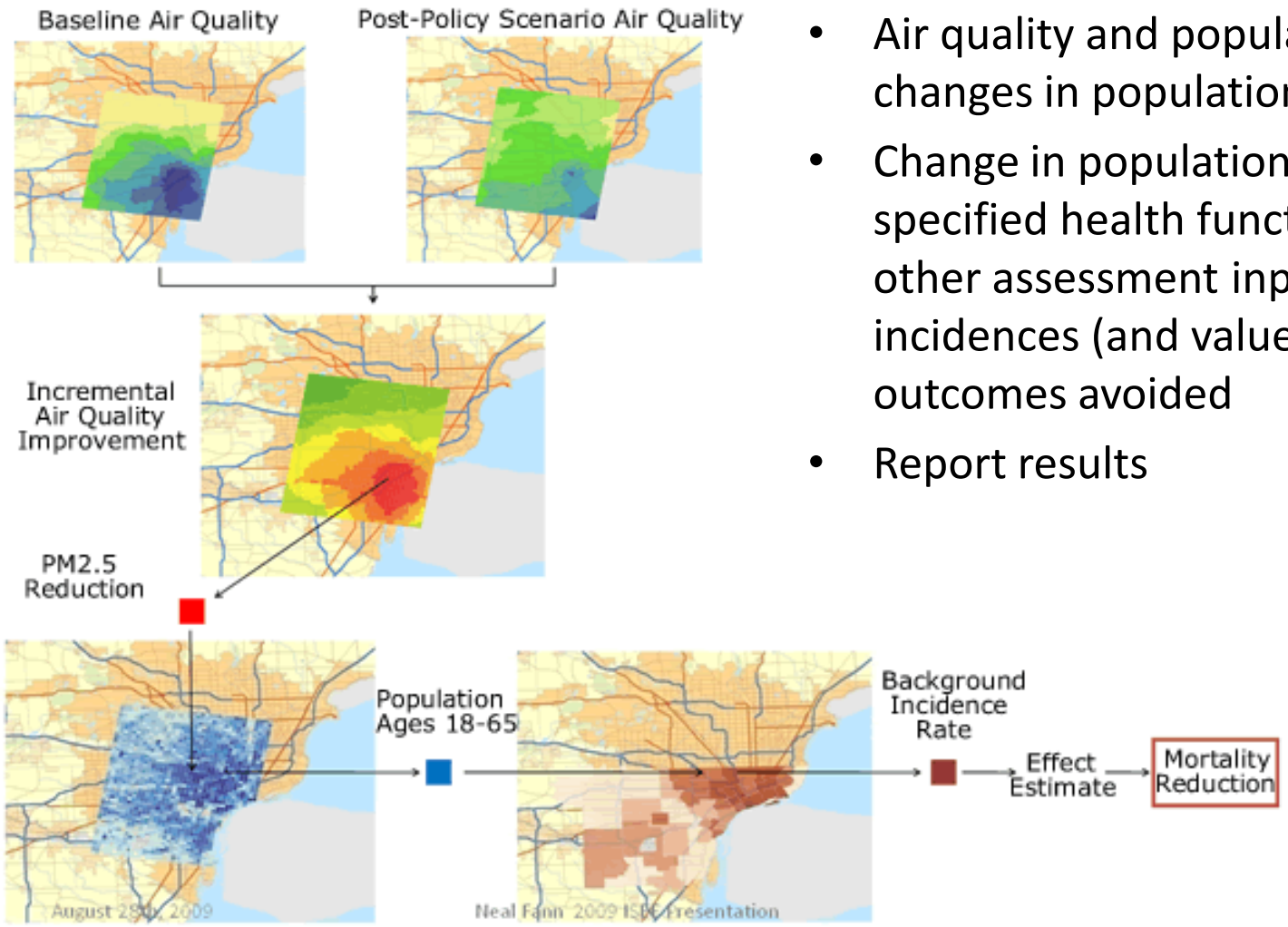
Health Endpoint	***Particulate Matter***	***Ozone***
Mortality	✓	✓
Chronic bronchitis	✓	
Nonfatal heart attacks	✓	
Hospital admissions	✓	✓
Asthma ER visits	✓	✓
Acute respiratory symptoms	✓	✓
Asthma attacks	✓	✓
Work loss days	✓	
Worker productivity		✓
School absence rates		✓

Data BenMAP Uses to Perform a Benefits Analysis



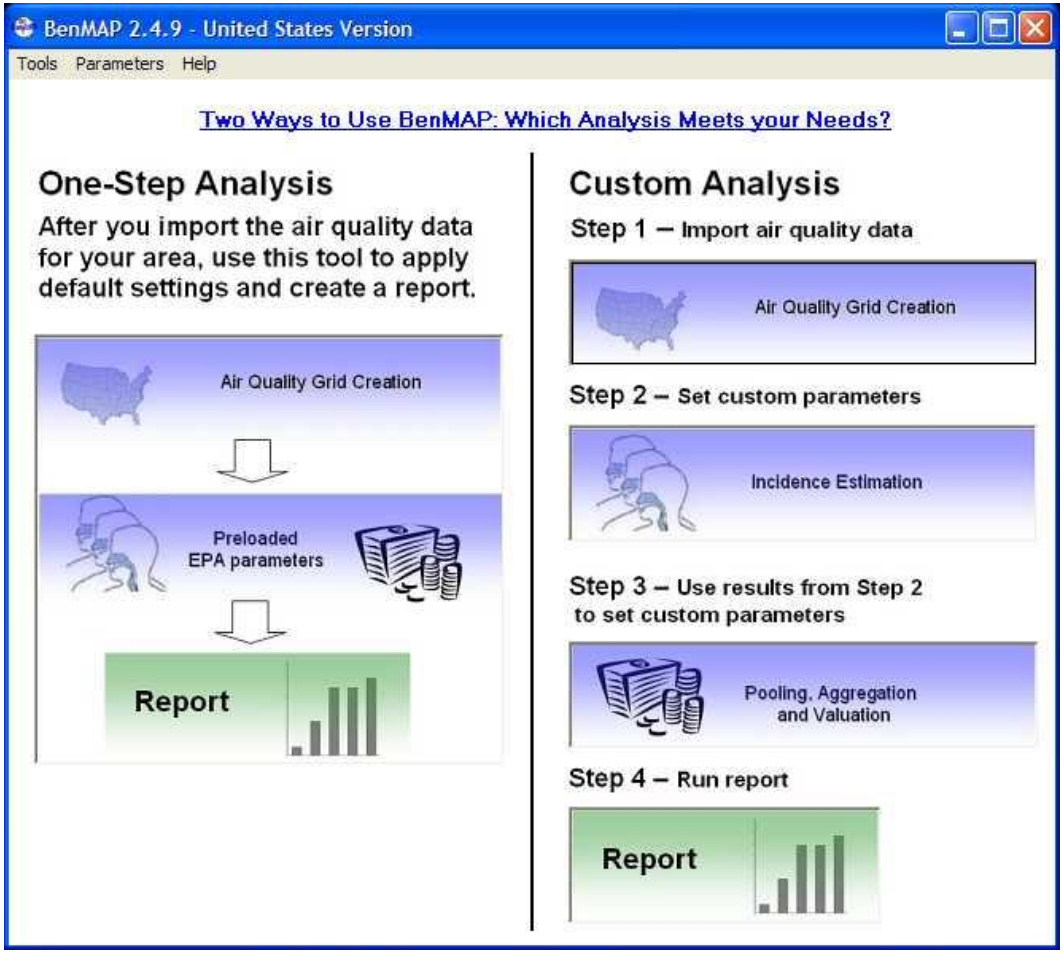
Gray text represents user specification or model input
Black text represents result from inputs

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

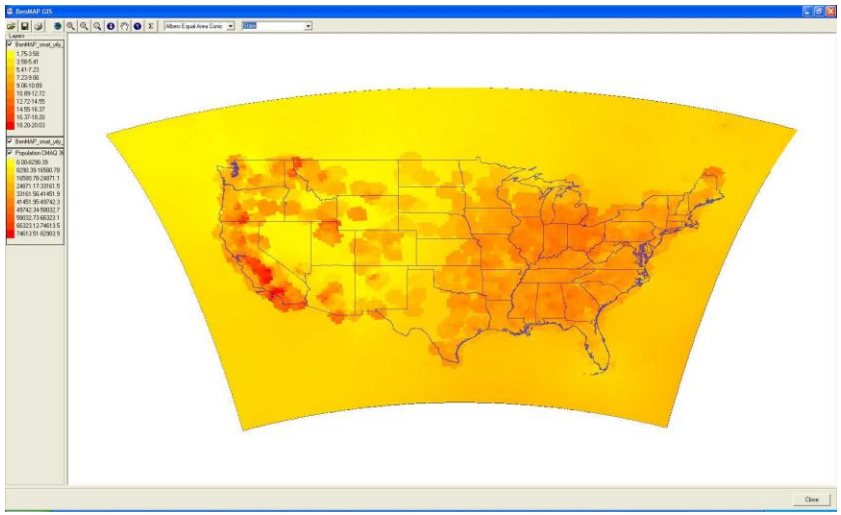
BenMAP Interface



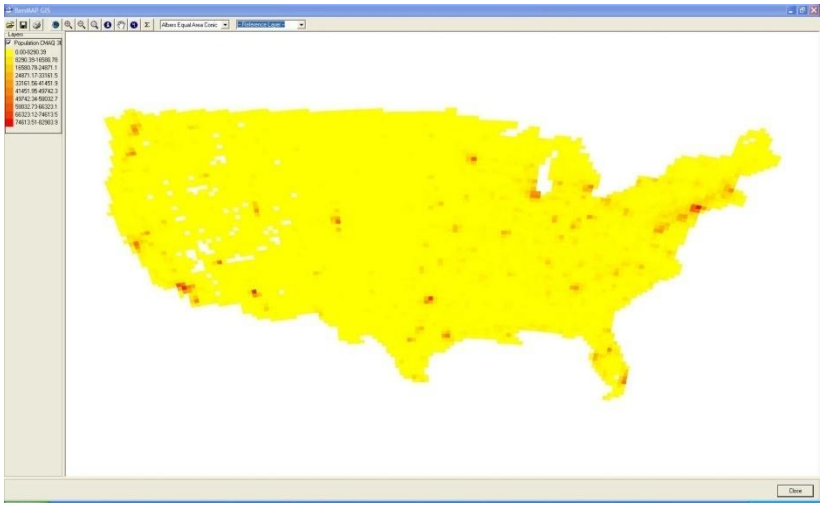
Air Quality Data

- Goal: Estimate change in population exposure to pollutant of interest
- Monitored air quality data
  - BenMAP includes built-in monitoring data
    - AIRS data for ozone, PM_{10}, 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

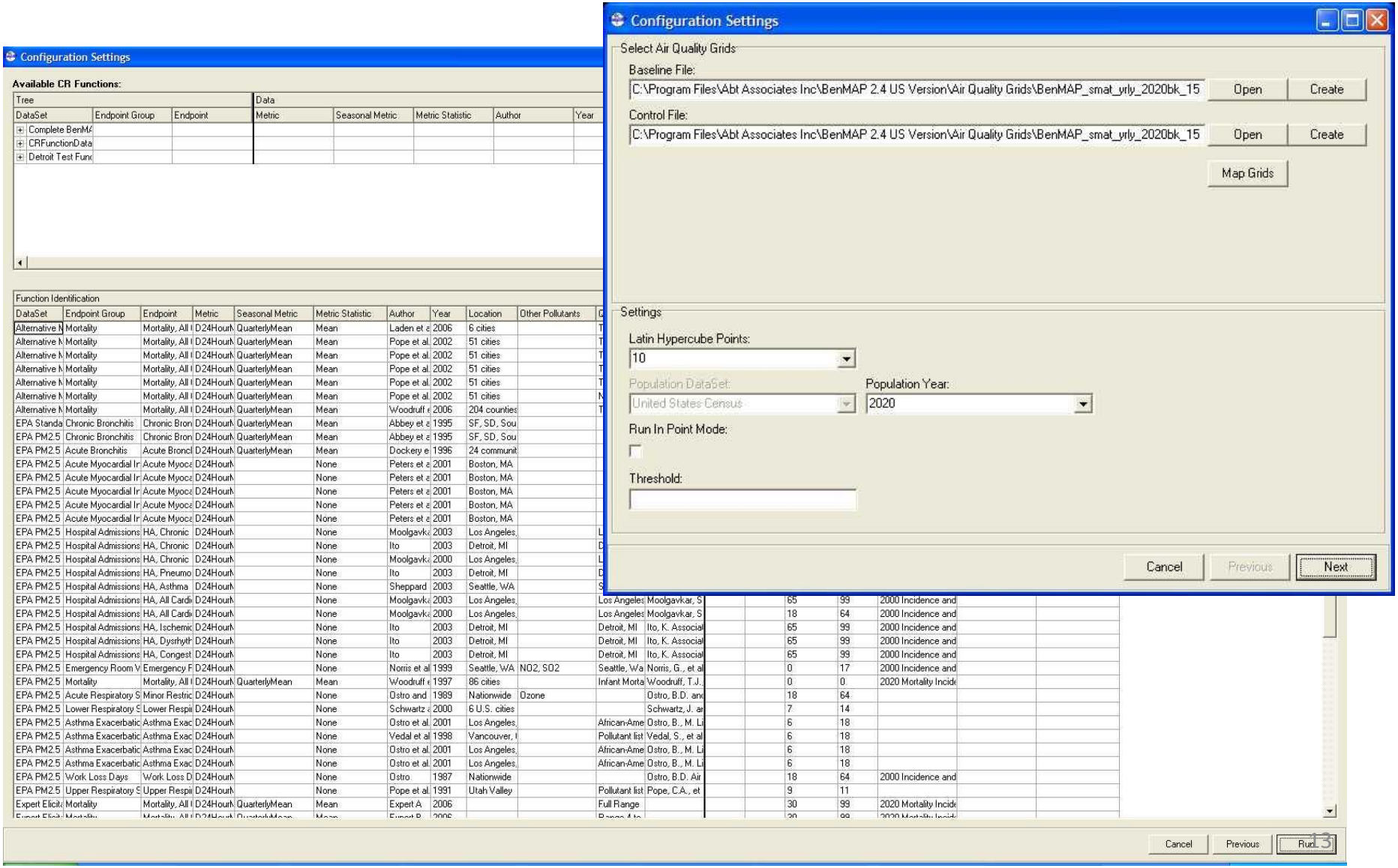


Population Distribution

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



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: 0
- Elements in Preview: 25

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
Mortality	25		62,761,504,768	62,714,671,104	31,262,892,032	9.77368376382178	-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
Mortality	30		27,557,281,792	27,535,820,800	15,347,742,720	2.35553213869615	-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	9,354,016,7
Mortality	0	Woodruff et al	90,529,712	90,313,144	103,571,488	1.07270523364311	-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	633,534,922,358,78	-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	1.23095370739116	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	115,542,25
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	5.80079013142E1	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	258,447,63
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 Exacerbatio			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	1.85824537152934	-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	8,314,332,6
Mortality		Pope et al.	24,481,386,496	24,463,034,368	13,631,747,072	1.85824537152934	-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	8,314,332,6
Mortality		Pope et al.	30,619,193,344	30,594,951,168	17,050,534,912	2.90720726008159	-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
Mortality		Pope et al.	34,434,789,376	34,406,346,752	19,181,977,600	3.67948241312076	-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
Mortality		Expert L	34,240,378,880	35,542,274,048	27,101,196,288	7.34474893254275	-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	4,988,466,1
Mortality		Expert K	8,152,312,832	8,139,760,640	14,370,235,392	2.06503659266936	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	9.39374884025774	-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
Mortality		Expert I	49,822,646,272	51,609,178,112	32,166,174,720	1.03466274862912	-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	9,689,190,4

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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