BAAQMD Modeling Advisory Committee Meeting on Particulate Matter

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Meeting Agenda

- Overall BAAQMD PM2.5 study program plan
- PM2.5 health impacts analysis
  - Input preparation
  - Description of BenMAP model
  - Application of BenMAP model
  - Discussion on BenMAP results
- Discussion on overall PM2.5 study plan
- Next meeting

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Overall PM2.5 Study Program Plan

- Data analysis
  - Cluster analysis, CMB analysis, graphical display of data, etc.
  - Conceptual description of elevated PM2.5 levels
  - Relate emissions and meteorology to PM2.5
  - Analyses are being updated with recent data

- Emissions inventory development
  - BAAQMD inventory for SFBA domain
  - ARB inventory for the rest of the domain
  - Updated ARB inventory may be available soon

- Modeling
  - MM5 and CMAQ
  - Modeling domain is the same as CCOS domain

Overall PM2.5 Study Program Plan (Cont.)

- Health impacts study

- Provide technical information to SIP/PM plan development effort

- Prepare documents, reports and papers
  - Preliminary modeling report available
  - Preliminary health impacts report available
  - Others on our website
  - Reports will be updated by December 2012

Health Impacts Study (today's topic)

US EPA developed two computer programs/models:

- BenMAP: Environmental Benefits Mapping and Analysis Program
    - Estimates ambient pollution exposure
    - Human health impacts
    - Monetary cost associated with human health impacts

- SHEDS: Stochastic Human Exposure and Dose Simulation Model
    - Also estimates ambient pollution exposure
    - Focuses on personal level exposure
    - Includes exposure to pesticides and other chemicals

Today, we will be talking about BenMAP applications

PM2.5 AQ Data Preparation for BenMAP

- Requires two sets of ambient data
    - Base
    - Control

- Requires quarterly and annually averaged data
    - Annual average is obtained from quarterly averages

- Data can be observed or simulated
    - Option #1: Interpolate PM2.5 observations
        - Interpolation may overestimate PM2.5 over the region
        - May not represent data-sparse areas
    - Option #2: Use simulated PM2.5 concentrations
        - This method may better represent spatial distribution of concentrations
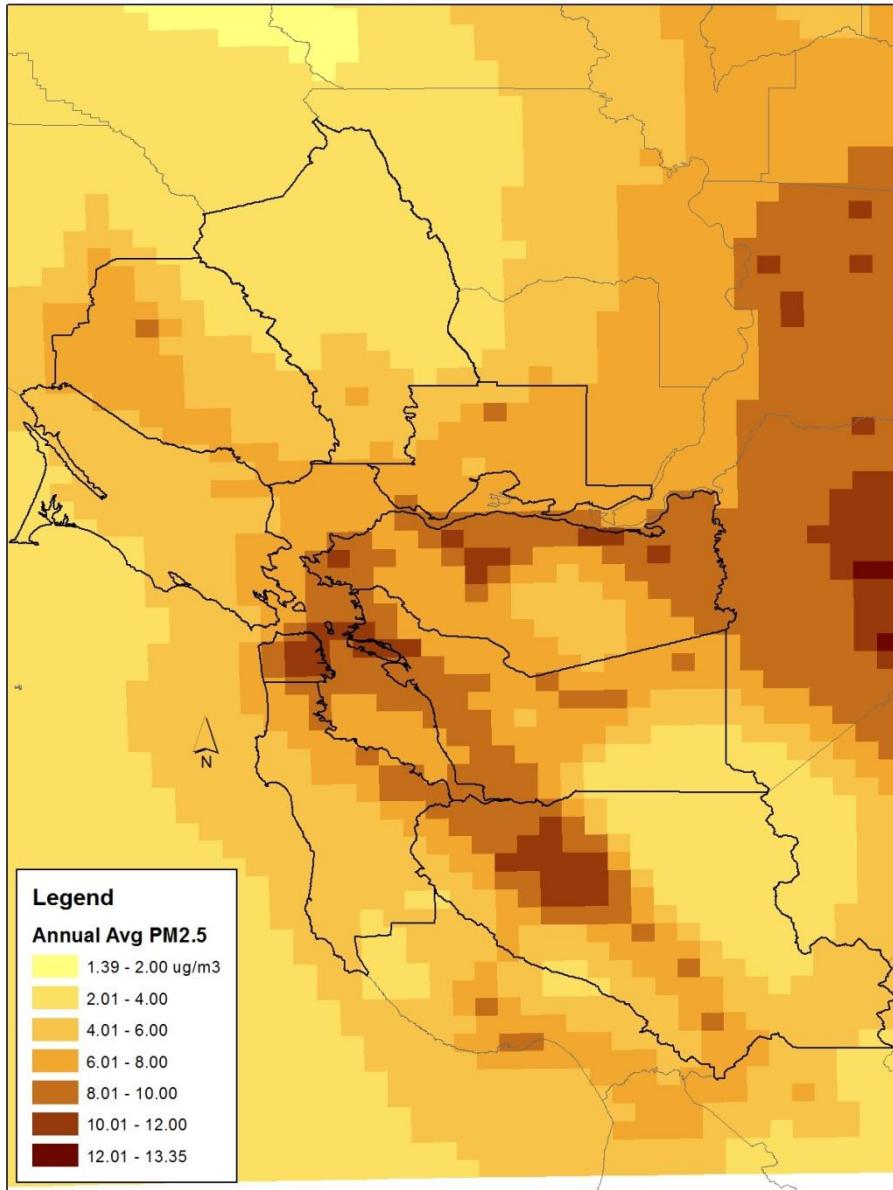
BAAQMD Applications

- Available PM2.5 simulations
    - December 1, 2006 – January 31, 2007
    - Emissions inputs - 2005
    - Model resolution – CMAQ (4 km horizontal resolution and 15 layers)
    - Model performance evaluation - conducted and documented
    - Reported to MAC at previous meetings

- BenMAP applications
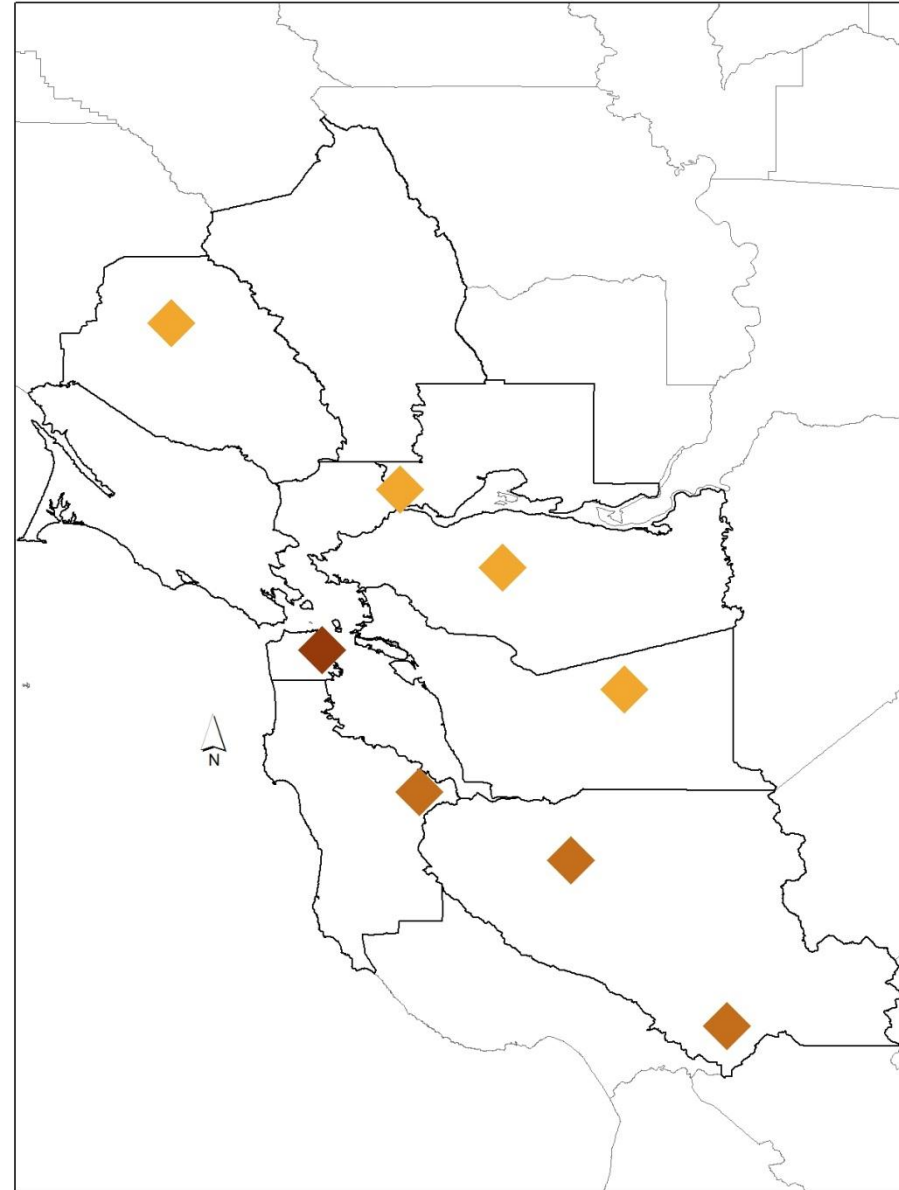   - 2010

BAAQMD Application Input Data

- Prepared data from available simulations for 2010 BenMAP application

  - Simulated design value (37 μg/m^3) matched to 2010 observed design value (31 μg/m^3)

  - Winter spatial pattern scaled to create data for other seasons
    - Summer PM2.5 levels assumed to be 1/4 of winter levels
    - Spring and fall levels assumed to be 1/3 to 1/2 of winter levels
    - Ratios were taken from observations in 2000
      - Non-winter concentrations for 2010 may be underestimated

- Uncertainty is expected in estimated annual average concentrations due to these assumptions

Observed and simulated annual average PM2.5 for 2010

Simulated

Observed

Legend

Annual Avg PM2.5

- 1.39 - 2.00 ug/m3
- 2.01 - 4.00
- 4.01 - 6.00
- 6.01 - 8.00
- 8.01 - 10.00
- 10.01 - 12.00
- 12.01 - 13.35

BenMAP

- Key Characteristics

  - Developed by US EPA over the last 10-15 years

  - Documented and peer-reviewed

  - Regularly updated and supported

  - Used in regulatory analyses
    - PM2.5 NAAQS

  - Designed for population-level analyses
    - *Average* exposure
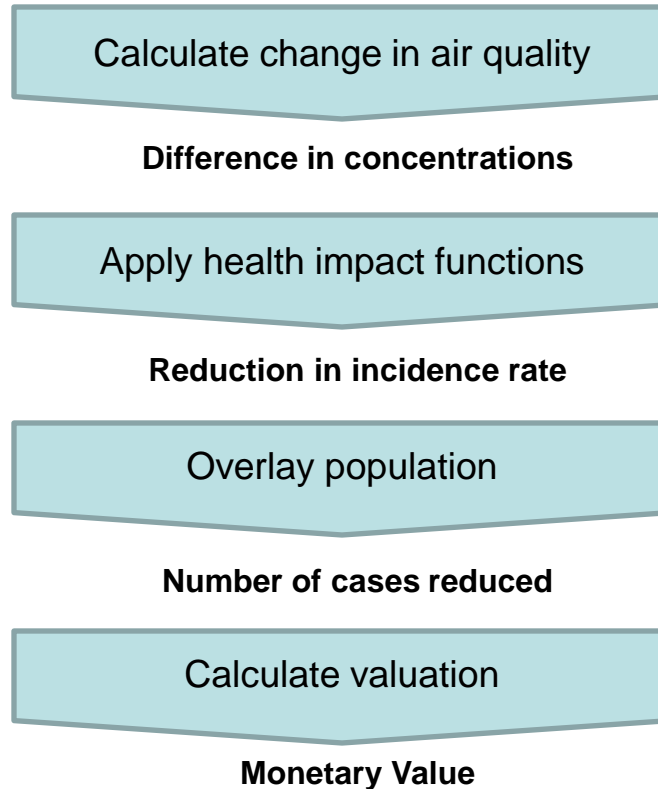
BenMAP (cont.)

- Key Characteristics (cont.)

    - Grounded on empirical observations
        - Health response functions
        - Prevalence and incidence rate data

    - Only health endpoints and affected populations with established impact functions are covered
        - Conservative estimates

    - Valuation is based on Willingness To Pay (WTP), which includes at least Cost of Illness (COI)

BenMAP (cont.)

- Inputs

  - PM2.5 concentrations
    - Two sets of concentration data always required
      - Difference in concentrations drives results
    - Metrics must match those used in health impact functions

  - Population data
    - Derived from 2000 US Census
    - Resolution must be same as concentration fields
    - Demographic categories (e.g. age groups) must match those used in health impact functions

BenMAP (cont.)

- Process

Calculate change in air quality

Difference in concentrations

Apply health impact functions

Reduction in incidence rate

Overlay population

Number of cases reduced

Calculate valuation

Monetary Value

BenMAP (cont.)

- Outputs

    - Incidence and Valuation
        - Morbidity
            - Illness or disease (asthma, heart attacks, etc)
        - Mortality
            - Premature death

Case Studies

- Case1
  - Estimated total health burden of anthropogenic PM2.5 in the Bay Area
  - Difference between 2010 PM2.5 levels and an assumed natural background level

- Case2
  - Estimated benefits of short to medium term PM2.5 reductions due to emission controls
  - Difference between 2010 PM2.5 levels and uniform 1µg/m3 reduction from the 2010 levels

Case1: Difference between 2010 PM2.5 levels and an assumed natural background level
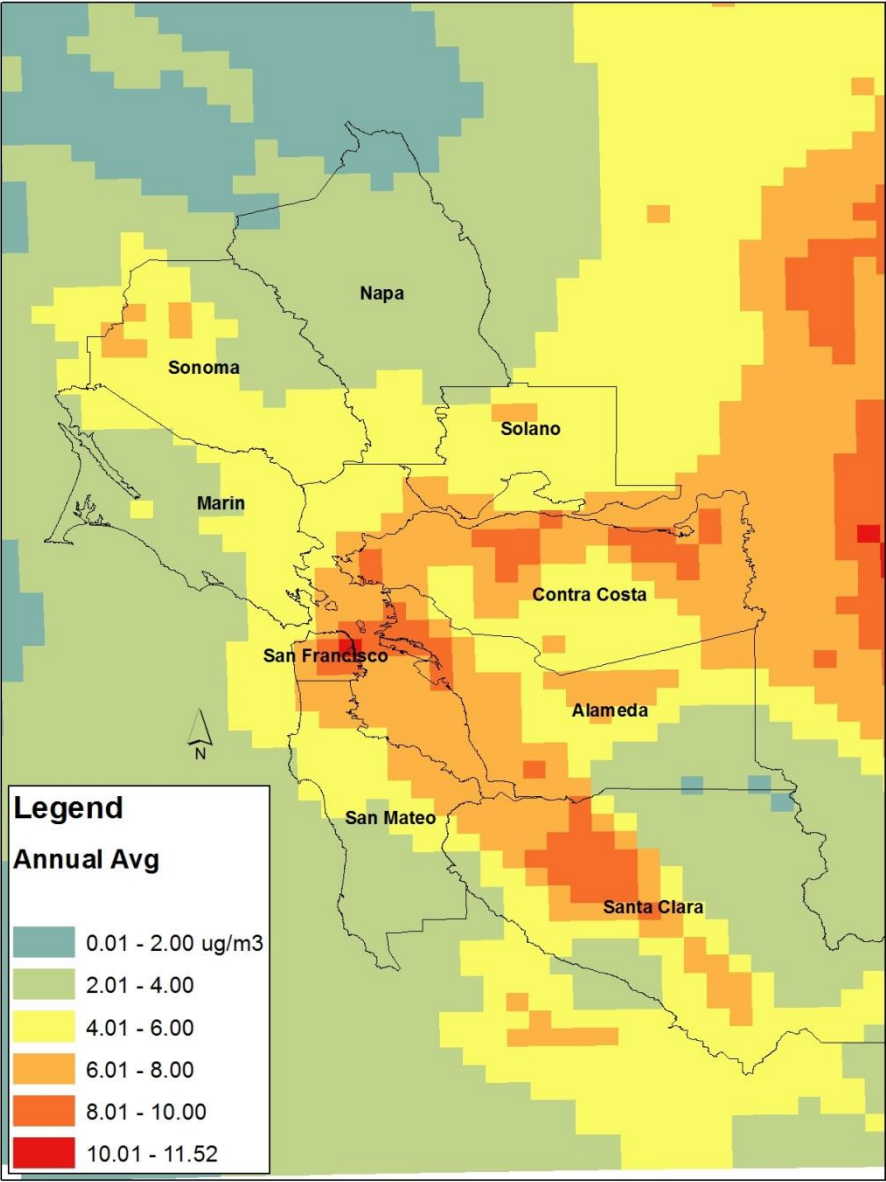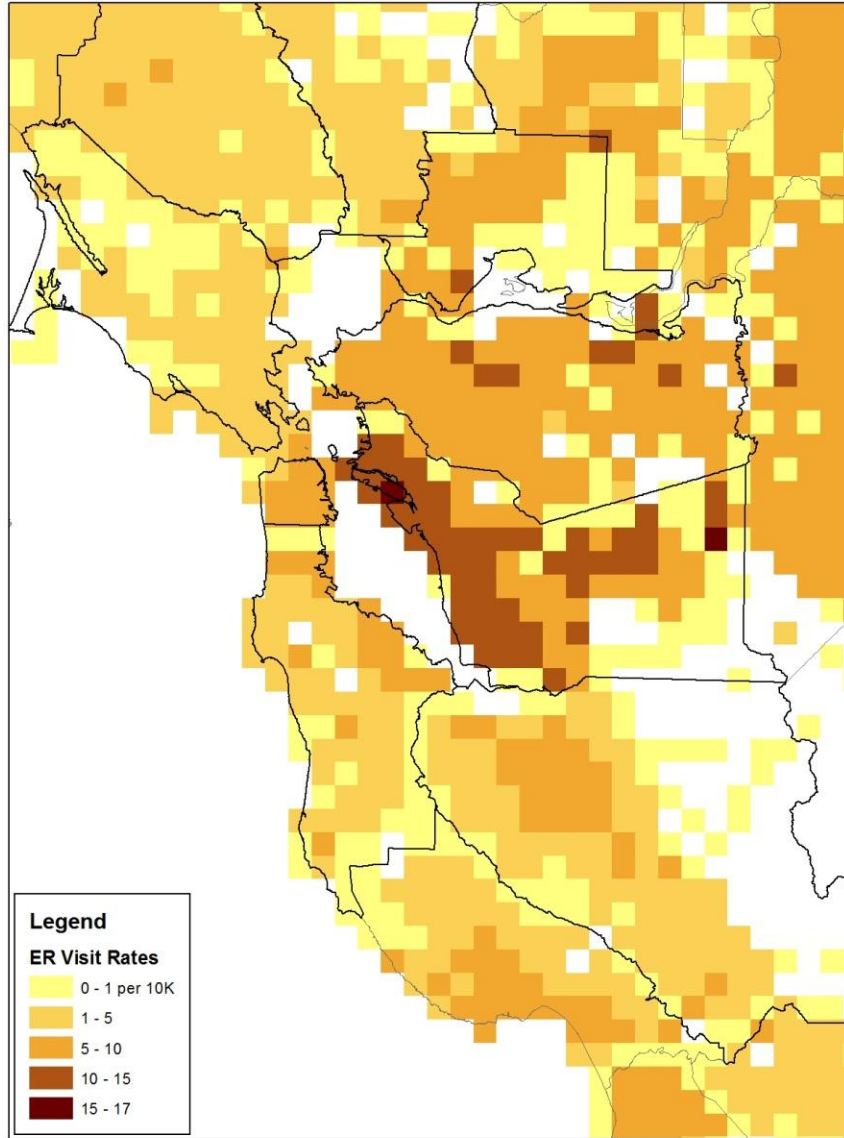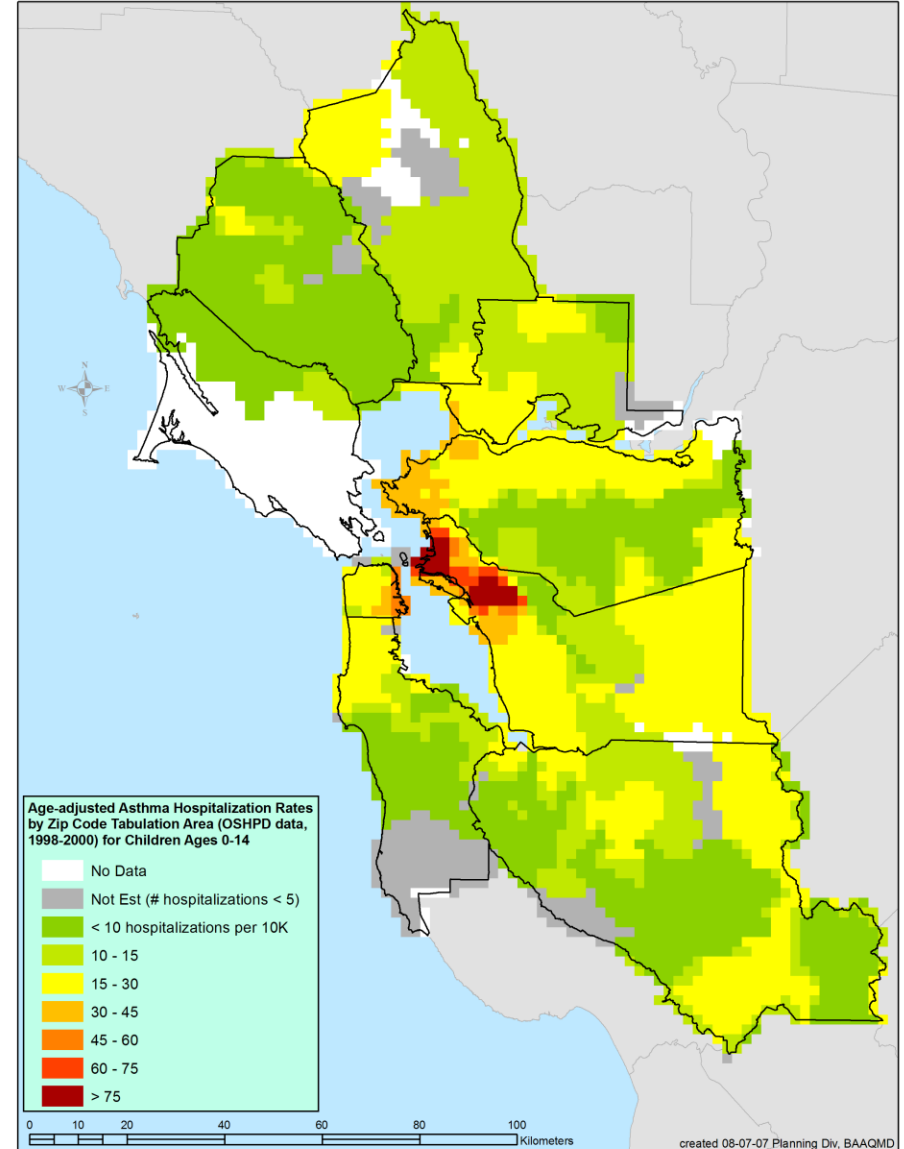
Case1: Morbidity and Mortality Impacts

Health Endpoint Group	Incidents Attributed to 2010 PM2.5
Mortality (all causes)	1,705
Chronic bronchitis	1,446
Acute myocardial infarction (nonfatal)	1,569
Hospital admissions, respiratory	477
Hospital admissions, cardiovascular	873
Emergency room visits, respiratory	1,116
Acute bronchitis	2,723
Lower respiratory symptoms	35,613
Upper respiratory symptoms	29,146
Acute respiratory symptoms	1,722,345
Work loss days	294,127
Asthma exacerbation	35,363

Case1: BenMAP and observed asthma-related ER visit and hospitalization rates for children

Estimated due to PM2.5

Total Observed

Legend
ER Visit Rates

- 0 - 1 per 10K
- 1 - 5
- 5 - 10
- 10 - 15
- 15 - 17

Age-adjusted Asthma Hospitalization Rates by Zip Code Tabulation Area (OSHPD data, 1998-2000) for Children Ages 0-14

- No Data
- Not Est (# hospitalizations < 5)
- < 10 hospitalizations per 10K
- 10 - 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 - 75
- > 75

0 10 20 40 60 80 100
Kilometers

created 08-07-07 Planning Div, BAAQMD

Case1: Mortality rates associated with 2010 PM2.5 levels

Legend
Mortality Rates
- 0 - 1 per 10K
- 1 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 45
- 45 - 55
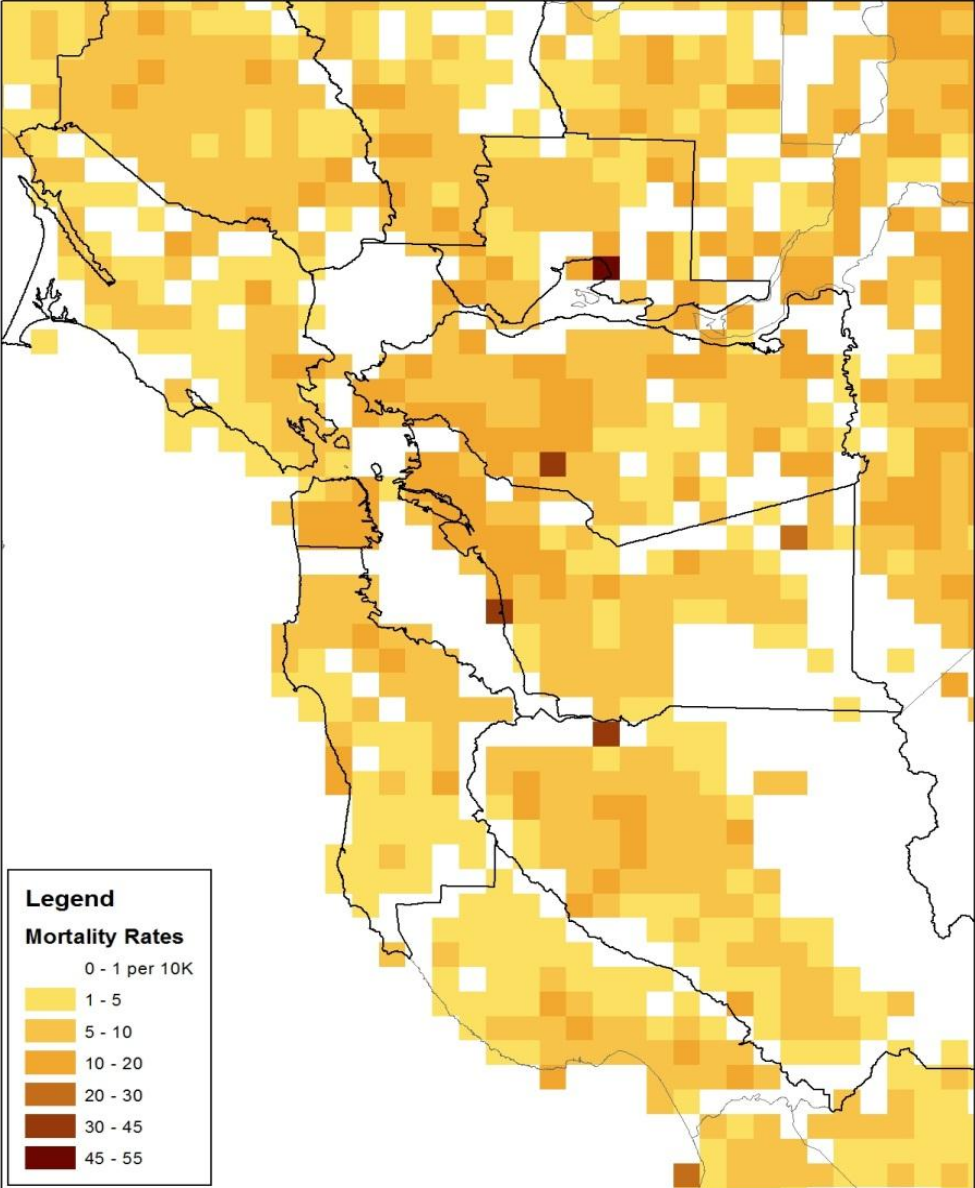
Case1: Morbidity and Mortality valuation associated with 2010 PM2.5 levels

County	Morbidity Valuation (million)	Mortality Valuation (million)	Total (million)
Alameda	$201	$2,715	$2,916
Contra Costa	$154	$2,206	$2,360
Marin	$25	$410	$435
Napa	$11	$216	$227
San Francisco	$119	$1,893	$2,012
San Mateo	$69	$1,000	$1,069
Santa Clara	$237	$2,728	$2,965
Solano	$44	$614	$658
Sonoma	$50	$806	$856
Grand Total	$910	$12,588	$13,498

Case2: Morbidity and Mortality benefits per μg/m3 reduction in PM2.5

Health Endpoint Group	Total Incidents Reduced
Mortality (all causes)	66
Chronic bronchitis	61
Acute myocardial infarction (nonfatal)	71
Hospital admissions, respiratory	19
Hospital admissions, cardiovascular	29
Emergency room visits, respiratory	46
Acute bronchitis	117
Lower respiratory symptoms	1,493
Upper respiratory symptoms	1,126
Acute respiratory symptoms	68,348
Work loss days	11,530
Asthma exacerbation	1,362

Summary and Key Findings

- Despite attainment, PM2.5 health impacts are significant in BA
- Health impacts and valuation of 2010 levels (31 µg/m^3 98th percentile)
  - Morbidity incidents 2,125,000 per year
  - Cost $910 million per year
  - Mortality incidents 1,705 per year
  - Cost $12.6 billion per year

- Benefit of reducing annual average 2010 levels (winter reduced 1 µg/m^3)
  - Avoided morbidity incidents 84,202 per year
  - Avoided cost $37 million per year
  - Avoided mortality incidents 66 per year
  - Avoided cost $500 million per year

Planned Enhancements

Previous simulations

- Meteorology and air quality (December 1, 2006 – January 31, 2007)
- Emissions - 2005

On-going simulations for enhancements and better representation

- Meteorology and air quality (first two weeks of the following months for 2010)
  - January and March
  - May
  - August
  - October and December
- Emissions - 2010

Planned Enhancements (cont.)

- Census data for BenMAP - 2010
- Health impact analysis for various emission control scenarios
  - Wood burning emissions
  - Diesel truck retrofit
  - Spare the Air day program
  - Others
- Update all reports

Next MAC Meetings

- May 2012 – Key findings from overall BAAQMD PM2.5 study

- October 2012 – Preliminary results from ultrafine PM study