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EPA Lead NAAQS RIA: Human Health Benefits Assessment

EPA/SAB HAP Benefits Analysis Workshop

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Overview

- Analytical goals
- Key issues
- Model design
- Modeling inputs and assumptions
- Example results
- Potential limitations and uncertainties

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Analytical Goal

- Provide a credible estimate of the human health benefits of attaining alternate Pb NAAQS
  - Broad geographic scope
  - Both quantify and estimates monetary value of incidence changes
  - RIA does not directly inform standard setting process

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Key Issues

- Lack of air quality modeling inputs to the benefits assessment
- Less complete monitoring coverage
- Technique for calculating changes in incidence
- Benefits model

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Model Design Overview

- Developed spreadsheet-based screening model
  - Value of information approach
  - Allows rapid evaluation of different model inputs and assumptions
  - Model design appropriate for available data
- Used Environmental Benefits Mapping and Analysis Program (BenMAP) to create air quality surfaces for exposure analysis.

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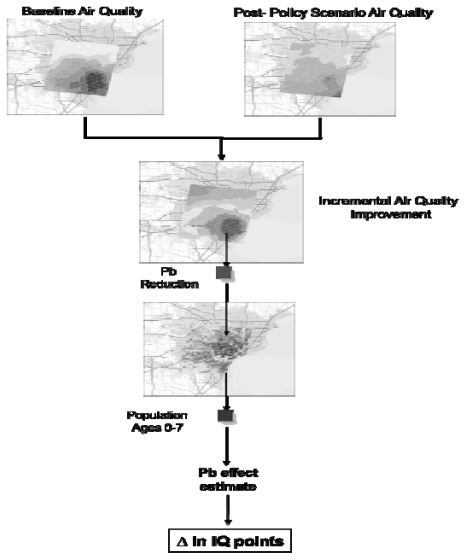
Overview



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Modeling Inputs

- Four key model inputs
  1. Changes in Pb air quality
  2. Exposed population
  3. Calculation of health impacts
  4. Valuation of incidence
- Will estimate air quality inputs through monitor rollback technique
  - Start with baseline monitor values
  - Roll back all monitors above alternate Pb NAAQS
  - Perform spatial interpolations to create:
    - Baseline spatial surface
    - Roll-back spatial surface
  - Repeat process for each Pb NAAQS alternative
  - Sparse monitoring network complicates this process

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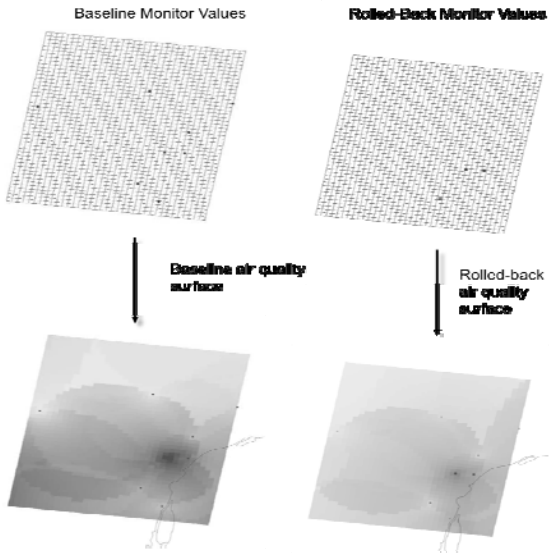
Exposure Analysis



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Modeling Inputs: Exposure

- Exposure estimates
  - Population projected to 2016
  - Includes population stratified by ages relevant to health impact functions
  - Considering direct inhalation route of exposure only
    - Not considering ingestion exposure resulting from inhalation exposure
  - Air-to-blood ratios
    - Relate changes in ambient lead to changes in blood lead
    - Considered a range of ratios from literature, ranging from 1:2 to 1:10
    - For primary analysis, selected a ratio of 1:7

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Modeling Inputs: Dose-Response Functions

- IQ point gains
  - Based on epi studies showing inverse IQ/blood lead relationship in children under 7.
  - Primary estimate based on pooled analysis by Lanphear et al., 2005
  - Log-linear model with low exposure linearization
  - No threshold; cannot be discerned from currently available studies
    - Steeper slopes observed at lower blood Pb concentrations
  - Sensitivity analysis with alternative functions (e.g., Canfield et al, 2003)

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Modeling Inputs: Valuation Functions

- Valuation estimates
  - IQ loss related to future productivity and earnings.
  - Measure benefits as avoided foregone future earnings
  - Consistent with past EPA analyses
  - Estimated current lifetime earnings from 2006 CPS
  - Used Salkever (1995) and Schwartz (1994) analyses of impact of IQ on earnings to generate range of values.
- Used $PM_{2.5}$ benefit per ton estimates to value PM reductions, based on:
  - Pope et al., 2002
  - Laden et al., 2006
  - PM/mortality expert elicitation (EPA, 2006)

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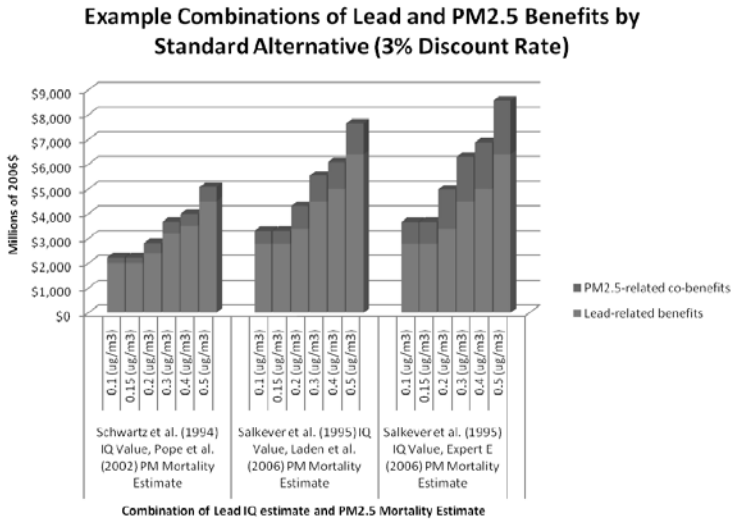
Example Results

Figure 5-1. Lead and PM $_{2.5}$ Benefits by Standard Alternative (3% Discount Rate)



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Sensitivity Analyses

- Air quality
  - Exposure estimation techniques
- Health incidence
  - Air-to-blood ratios
  - IQ and blood pressure studies
  - Background blood lead levels
- Valuation estimates
  - IQ study

Influence of Key Inputs on Benefits Estimates

Variable	*Model Input*	*Percent Change from Default Value (%)*
Exposure Estimation Method	**Interpolation**	---
	1 km radius	-94
Air:Blood Ratios (µg/m3 in air: µg/dl blood lead)	**1:7**	---
	1:2	-50
	1:10	+18
Epidemiological Study for IQ	**Lanphear (2005)**	---
	Canfield (2003)	-48
	Lanphear Dual Linear (2005)	+140
Valuation Study for IQ	**Salkever (1995)**	---
	Schwartz (1994)	-30

Limitations and Uncertainties

- Model limitations
  - More tenuous link between emission controls and air quality improvements
  - All model inputs treated as point estimates
    - A-4 requires probabilistic treatment of uncertainty for rules with impacts estimated to exceed $1B
- Uncertainties
  - Air to blood ratios
    - Highly simplified approach
    - Lack of ratios to estimate adult exposure

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Impacts not Quantified

Children:

- Premature infant mortality

Adults:

- Hypertension
- Chronic heart disease (CHD)
- Stroke
- Premature mortality
- Certain adult endpoints estimated through a "secondary approach" or sequelae

Primary approach

Δ in blood Pb → Δ in IQ points

Secondary approach

Δ in blood Pb → Δ in blood pressure → Δ in stroke

Society:

- Effect of reduced lead exposure on delinquent behavior and crime

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