



A Feasibility Study on Assessing Public Health Impacts of Cumulative Air Pollution Reduction Activities in New Haven, CT Using Hybrid Air Quality and Exposure Modeling Methodologies

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Contributing Organizations: ORD: NERL, NHEERL; Region 1



B · O · S · C HUMAN HEALTH PROGRAM REVIEW

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RESEARCH & DEVELOPMENT

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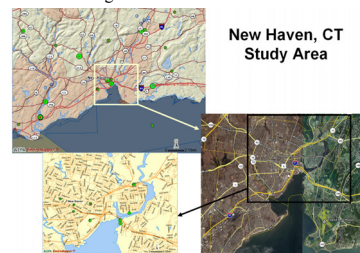
Science Questions

- What types of existing human health data and ambient exposure-related data are available for the purposes of conducting an air accountability study in New Haven, CT?
- Are there relevant past or on-going research studies that examine the linkage between exposure to air pollution and health in New Haven, CT?
- What types of de novo data collection will be needed to cover gaps in information not available in the existing health or exposure-related data?
- How can we establish collaborations and partnerships with state and local agencies including government, academia and community?
- Are there existing or new and innovative air quality and exposure modeling methodologies that can be used for assessing the linkages between air pollution exposures and health outcomes?
- Based on past and projected future air quality conditions, can we determine statistically the feasibility of carrying-out an air accountability study in New Haven, CT?

Existing Data Availability:

- Only 4 ambient monitors in study domain
- No existing human exposure to air pollution data available
- 17 different health outcome databases were identified
 - Differences exist for access to the databases
 - No one database contains all necessary information for accountability

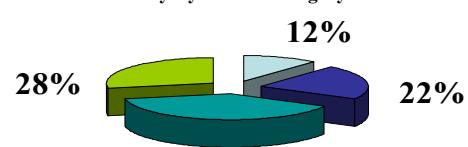
- Project originated from an ORD wide solicitation
- Regions submitted pre-proposals
- ORD design teams were established and created full proposals



Why New Haven?

- Highest children asthma emergency room visits in CT
- NE County with 2nd highest NATA cancer risks
- PM and Ozone noncompliance
- City, state & community partnerships and actions

New Haven Inventory By Source Category



Weil M. (2004) New Haven Air Toxics Inventory and Risk Reduction Strategy. <http://www.cityofnewhaven.com/CityPlan/pdfs/EnvironmentalInitiatives/AirToxicsProject/InventoryReport.pdf>

Research Design Strategies, Data Sources, and Statistical Techniques

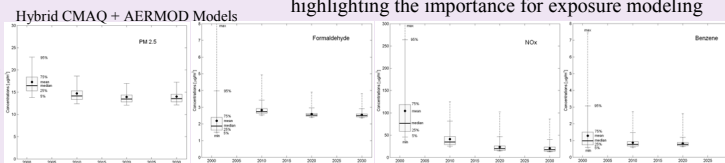
- White paper: outlines methodologies and tools that can be used for accountability research on a local city scale with the use of existing data
- Existing Ambient Air Quality Data
 - 6 ambient air monitors in City of New Haven operated by Connecticut Department of Environmental Protection
 - Currently only 4 are active
- Existing Exposure Data
 - None identified

Existing Human Health Data

- Hospital discharge data (CHIME)
- Vital records
- Birth defects registry
- Connecticut Department of Public Health's Asthma program
 - Asthma surveillance
 - School based asthma surveillance
- Medicaid data – HUSKY
- School absenteeism
- CT Tumor Registry
- Emergency services data
- Hill Health Community Health Center Data
- New Haven Health Project

Findings and Conclusions

- Model simulations for future projections indicate overall decrease in median pollutant concentrations due to local sources between 2001& 2010 have been modest (except for NOx), but quite significant for the high end of the distribution
- Slight decreases in median pollution levels over the 2010-2030 are projected with a few hot spots still remaining



- Both magnitude and spatial patterns of modeled exposures versus concentrations are different, highlighting the importance for exposure modeling

Feasibility:

- 34 different pollutant/health outcome linkages were assessed for five different pollutants: arsenic, benzene, diesel exhaust particles, NO₂, and PM
- 12 linkages not feasible but 4 potentially feasible
- For those 4 potential linkages, feasibility has not yet been determined in the context of air quality associated health impacts
- 20 linkages may be possible with an alternative (e.g., intra-urban gradient based) study design rather than an "ideal" design

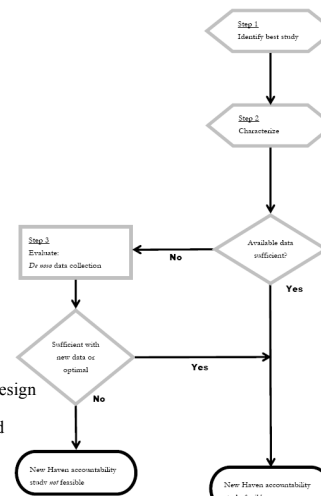
Methods/Approach

Regulatory and Voluntary Actions to Consider

- National regulations for mobile sources
 - Road
 - Non-road
- Voluntary actions for mobile sources
 - Road
 - Non-road
- National regulations for stationary sources
- Voluntary actions for stationary sources
- Indoor air reduction activities

Feasibility Analysis

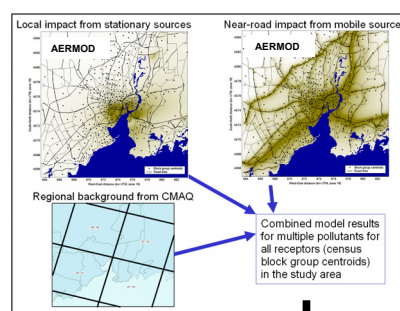
- Identify preferred study designs
 - Data availability?
 - Statistical power?
- Identify alternative study designs
 - Data availability?
 - Statistical power?
- Feasibility designations
 - Currently potentially feasible
 - Potentially feasible with alternative design
 - Potentially feasible with new data
 - Potentially feasible with new data and alternative design
 - Not feasible
 - Could not determine



Potential Feasibility Flow Chart

Modeling Ambient Concentrations

- PM, ozone, and selected air toxics concentrations in the study domain
- Hybrid modeling approach to resolve local scale, whereby:
 - CMAQ provides regional background and contribution from chemically-reactive pollutants
 - Near-source concentrations provided by local-scale dispersion models, e.g. AERMOD
 - Total (combined) concentrations used as input to estimate inhalation exposures

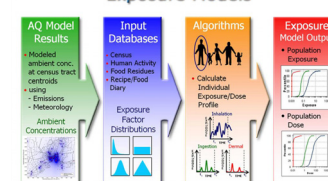


A hybrid modeling approach was used to incorporate both regional and local scale impacts from the base year (2001) and projections based on air pollution reduction activities for 2010, 2020, and 2030 for multiple criteria and toxic air pollutants of concern in New Haven CT (Criteria: PM10, PM2.5, NOx, SO2, CO; Toxics: Benzene, 1,3-Butadiene, Formaldehyde, Diesel PM, 2,2,4-Trimethylpentane, POM, Naphthalene, Acrolein, Chromium compounds, Dioxin compounds).

Application of Air Quality Models in Air Accountability Studies

- Simulating air quality impacts for various controls scenarios, for example:
 - what happens if emissions from some specific stationary sources are reduced by "x" percent?
 - what happens if emissions from mobile sources could be reduced by "y" percent?
 - what is the impact of local controls?
 - what is the impact of regional/national controls resulting in reduction of regional background?

Linking Air Quality Models to Exposure Models

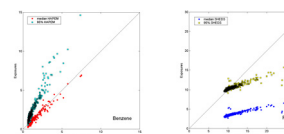


Exposure Modeling

- Evaluate alternative techniques for estimating cumulative exposures to selected air toxics, PM, and ozone
- Probabilistic cumulative exposure models: HAPEM6 and SHEDS-Air Toxics
 - time-series based models using human activity pattern data, modeled/measured concentrations, exposure factors

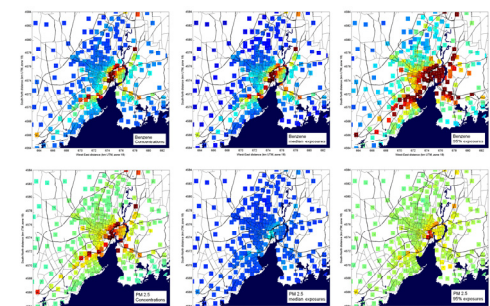
Modeling Exposures Using HAPEM and SHEDS

- Modify HAPEM6:
 - to enhance its time-averaging capabilities ranging from hours to days to months
 - to enable it to calculate exposures to multiple pollutants by the same individual (e.g., time-activity patterns, ME factors, commuting patterns, etc.)
 - to have it provide exposure estimates at either, census block, census block group or census tract
- Obtain representative ME factors from the recent HAPEM application for the NATA study
- Using the ME factors, run the modified HAPEM6 and SHEDS-Air Toxics to predict cumulative exposures to selected air toxics in New Haven



Findings: Exposures and concentrations are different

- Benzene typically infiltrates readily indoors, hence median exposures are similar to ambient concentrations
- However, population subgroups have higher exposures due to elevated residential outdoor levels near roadways estimated by HAPEM model
- PM2.5 penetrates less efficiently indoors, thus personal exposures to PM2.5 ranges between 40 to 100 % of ambient PM2.5 concentration values (from SHEDS model)



Findings: Mobile sources are major contributor to local-scale variability in both concentrations and exposures. Thus, it is important to accurately characterize near-road impacts

Impact and Outcomes

- The overall goal of ORD's research program on approaches to evaluating the outcome due to Agency's regulatory and environmental risk management decisions is to develop tools, methodologies and models that can be used in such program evaluations. Tools developed as part of this research include:
 - Documented availability of existing human health, ambient air quality, air emissions, and air exposure related data available for a small geographic area, specifically a city
 - Developed stationary source and link-based mobile source emissions inventories for the city of New Haven, CT for the base year of 2001 and for the future year regulatory and emissions scenarios: 2010, 2020, and 2030.
 - Using the site-specific emissions inventory, applied hybrid (i.e., regional and local-scale) air quality models for predicting air quality concentrations as well as population exposures over the 2001-2030 study period.
 - Performed a feasibility analysis of conducting an air accountability study at a local level in New Haven using measured and modeled air quality and exposure data.
- Although this study targets one city, application of the information collection activities will have broad application to other areas within the United States.
- The information derived from this study will be used by EPA as a resource for future air accountability research planning.

Future Directions

- For those outcomes/exposure scenarios not feasible:
 - Determine what data needed to adequately link exposure-related information with available health data
 - Existing data?
 - De novo data collection?
 - Health surrogates?
 - Determine what additional analyses are needed – model health? Different modeled exposure?
- Examine possibility of utilizing techniques developed for New Haven and lessons learned in other local areas or communities

Researchers Involved

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Evaluation of Risk Management Decisions