



Project Summary

Framework for Uncertainty Analysis of the NAPAP Emissions Inventory

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The objective of this project is to develop a methodologies framework to assess the uncertainties associated with the emissions values as presented in the National Acid Precipitation Assessment Program (NAPAP) emissions inventory and to implement a prototype computer system to estimate the uncertainties associated with the base NAPAP emissions values. Previous projects that addressed the assignment of quantitative values to the uncertainties in emissions data were reviewed, and a statistical methodology was developed that allows the computation of more accurate uncertainty values. Auxiliary data required to carry out the computations were identified, and the prototype computer system to implement the calculations has been designed and is being implemented.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The NAPAP emissions inventory was based on the National Emissions Data System (NEDS) currently operated by the Office of Air Quality Planning and Standards (OAQPS) of EPA (National Air Data Branch, 1983). NEDS provided the basic data from which all other levels of aggregation or disaggregation will be calculated. The basic NEDS data are statistical averaged parameters which allow the calculation of yearly emissions of the five

criteria pollutants (particulates, SO_x , NO_x , hydrocarbons, and CO) on an individual source/process basis for point sources and on a county level for area sources. Current plans call for the application of spatial, temporal, and species disaggregation algorithms which will be based on disaggregation factors (or modifications thereof) developed for the Northeast Corridor Regional Modeling Project (NECRMP). Higher levels of aggregation will be calculated as sums of the NEDS data.

Calculation of the uncertainty of the emissions values will be based on the statistical formulas expressing the variance of a function based on the expected values and variances of the parameters used to calculate the function. Application of these techniques will start with the algorithms used to calculate the yearly emissions values and will be extended to include currently known algorithms for spatial and temporal aggregation and spatial, temporal, and species disaggregation, as applicable.

Theoretical Background

The statistical formulas to be used are those expressing the variance of a function based on the expected values and the variances of the parameters used to calculate the function. For N independent parameters and a function of the form $x =$

$\sum_{k=1}^N U_k$, the variance is given by:

$$V(x) = \sum_{k=1}^N V(U_k) \quad (1)$$

For a function of the form $x = \pi \sum_{k=1}^N U_k$, the

variance is given by:

$$V(x) = \frac{1}{N} \sum_{i=1}^N \{ [E(U_i)]^2 + V(U_i) \} - \left(\frac{1}{N} \sum_{i=1}^N [E(U_i)]^2 \right)^2 \quad (2)$$

where $E(\)$ represents the expected value and $V(\)$ represents the variance of a population. The sample mean and the sample variance can be used as estimators of the population expected value and variance; equations (1) and (2) are exact for these estimators as they are for the population moments.

Review of Previous Work

Several previous projects have addressed the problem of assigning, in statistical terms, quantitative values to the errors in emissions data. Final reports from the following projects were reviewed.

1. Weighted Sensitivity Analysis of Emissions Data, project conducted by IBM Corporation under contract to the Office of Air Quality Planning and Standards (OAQPS), EPA, July 1973.
2. Source Inventory and Emission Factor Analysis (SIEFA) project conducted by PEDCo - Environmental Specialists, Inc., under contract to OAQPS, September 1974.
3. Emissions Inventory for the SURE Region, project conducted by GCA Corporation under contract to the Electric Power Research Institute (EPRI), April 1981.
4. Emissions, Costs and Engineering Assessment, Work Group 3B, US-Canada Memorandum of Intent (MOI) on Transboundary Air Pollution, June 1982.
5. Preliminary Evaluation of Acidic Deposition Assessment Uncertainties, project conducted by Argonne National Laboratory (ANL) under contract to the U.S. Department of Energy, November 1982 (preliminary report).

All these projects have based their calculations on the statistical formulas for error propagation as derived for "small" values of the errors; i.e., the Taylor series expansion included only the first derivatives of the function. Some of the error values used in subsequent calculations have been as high as 80-90% of the mean. For errors of this size, the exact equations derived in this project represent more accurate solutions.

Implementation of Prototype Computer System

The final task of this project addresses the design and implementation of the basic framework of computer software needed to calculate uncertainties associated with yearly emissions values for both point and area sources. The conceptual design is independent of the software system used to support the NAPAP inventory; the design and implementation of the software modules will allow portability between computer systems and will be as independent as

possible of the current NAPAP inventory software system. Figure 1 is a schematic of this design.

Conclusion

Detailed quantification of the uncertainties associated with emissions values in the scale required by the NAPAP researchers has never been attempted before. In this project, methodologies have been developed to allow quantification of these uncertainties, and computer software has been developed to perform these calculations.

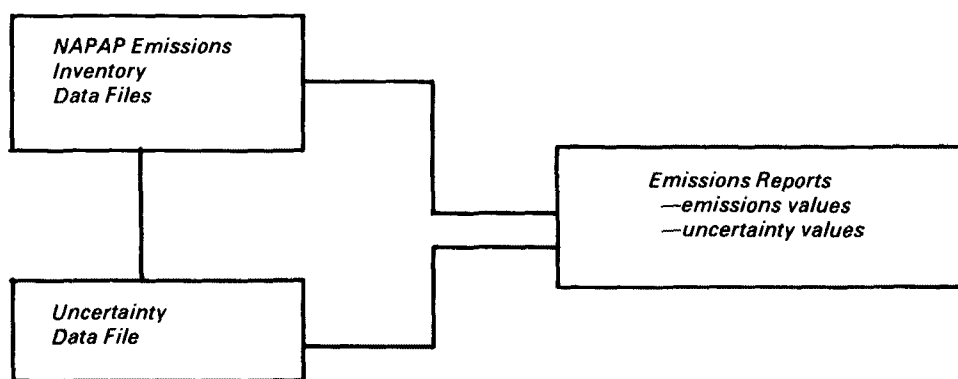


Figure 1. Implementation based on the current NAPAP emissions inventory system.

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The complete report, entitled "Framework for Uncertainty Analysis of the NAPAP
Emissions Inventory," (Order No. PB 86-112 570/AS; Cost: \$9.95, subject to
change) will be available only from:*

*National Technical Information Service
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