



Project Summary

Comparison of Historic SO₂ and NO_x Emission Data Sets

Gerhard Gschwandtner, Janice K. Wagner, and Rudolf B. Husar

During the past few years, several research projects have been conducted to reconstruct historic air pollution emission trends in the U.S. This report compares in detail the emission estimates derived by Gschwandtner et al. and Husar and attempts to determine the methodological differences that result in different emission estimates. In addition, the U.S. EPA historical trends, the electric utilities emissions estimates, and the NAPAP monthly trends inventory are compared to Gschwandtner's inventory. The inventories' differing objectives and reasons for the slightly varying emissions estimates are explained. On the national level, all estimates are in reasonable agreement. One objective of this study was to determine a basis for changing any of the existing estimates in order to minimize or eliminate unnecessary differences in reported national total emissions for common years. A revised set of NO_x and SO₂ emission estimates, based primarily on Gschwandtner and EPA trends, is recommended for use in future analyses utilizing historic emission estimates.

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 National Acid Precipitation Assessment Program (NAPAP) was established by Congress to conduct research on the causes and effects of acid precipitation. As part of this program, NAPAP's Emissions and Controls Task Group was formed to provide information on anthropogenic

sources of air pollution emissions. Several types of emission inventories have been produced to meet the various research needs of other task groups studying different aspects of the acid precipitation phenomenon. These include an extensive inventory for 1980 and historic inventories that span various periods of time. The historic inventories developed under NAPAP and the EPA support are summarized in Table 1. In addition, an inventory of historic SO₂ and NO_x emissions was prepared independently by Husar for the National Academy of Sciences.

Each of these inventories was developed to meet a different research objective. Each was based on a methodology most appropriate to achieving that objective. As a result, the methods and estimating techniques are slightly different, yet they yield similar estimating techniques are slightly different, yet they yield similar estimates of emission trends. This report attempts to identify the reasons for the differences and to resolve them.

Different Historic Sets

The major objective of each set of historic emissions estimates is described below.

G. Gschwandtner

The main objective of this inventory was to produce historic state level emission estimates of SO₂ and NO_x in a consistent manner that could be used as a common data set by various research groups in NAPAP.

R.B. Husar

The main objective was to develop methods for determining the trend in historic sulfur emissions and to explore the uncertainty of the emission estimates using various alternative methods and information.

Table 1. Available Historic Emissions Estimates

| Pollutant | Categories | Period | Temporal Resolution | Geographic Resolution | Principal Author |
|-----------------------------------|-------------------------|-----------|---------------------|-----------------------|------------------|
| SO ₂ , NO _x | All | 1900-1980 | Annual | State Level | G. Gschwandtner |
| SO ₂ , NO _x | All | 1890-1981 | Annual | State Level | R.B. Husar |
| All Criteria Pollutants | All | 1940-1985 | Annual* | National | U.S. EPA |
| SO ₂ , NO _x | Electric Utilities | 1975-1983 | Annual | Plant Level | E.H. Pechan |
| SO ₂ , NO _x | Utilities Non-Utilities | 1975-1984 | Monthly | State Level | D.A. Knudson |

*Available for 1940, 1950, 1960, 1965, and yearly from 1970 to 1985.

U.S. EPA

The main objective is to update the national emission trend for all criteria pollutants on an annual basis for previous years.

E.H. Pechan

The main objective of this file is to provide accurate SO₂ and NO_x emission estimates for individual power plants.

D.A. Knudson

The objective of this inventory is to provide monthly, state level emission trends of SO₂ and NO_x.

Given different objectives, different technical approaches were developed. Each approach necessarily required different input information. As a result, the total aggregated emissions estimated by each study are similar, but not identical. Figures 1 and 2 compare the total national SO₂ and NO_x emissions reported by the different studies. Figure 3 presents the revised emission estimates of Gschwandtner which reflect the EPA trends data.

This report examines the differences between the various historic emission estimates in detail, in order to understand and explain the differences. In addition, an attempt has been made to estimate the uncertainty of historic national emissions estimates.

Conclusions

1. The approaches used by Husar and Gschwandtner to develop historic SO₂ and NO_x emissions are comparable, and their estimates are similar when adjusted for differences in source category accounting.
2. Sulfur content of coal mined and shipped is about 20% higher than the sulfur of coal consumed, according to information reported by the U.S. Department of Energy. This discrepancy could not be resolved in this study. Further investigation is needed to determine if, in fact,

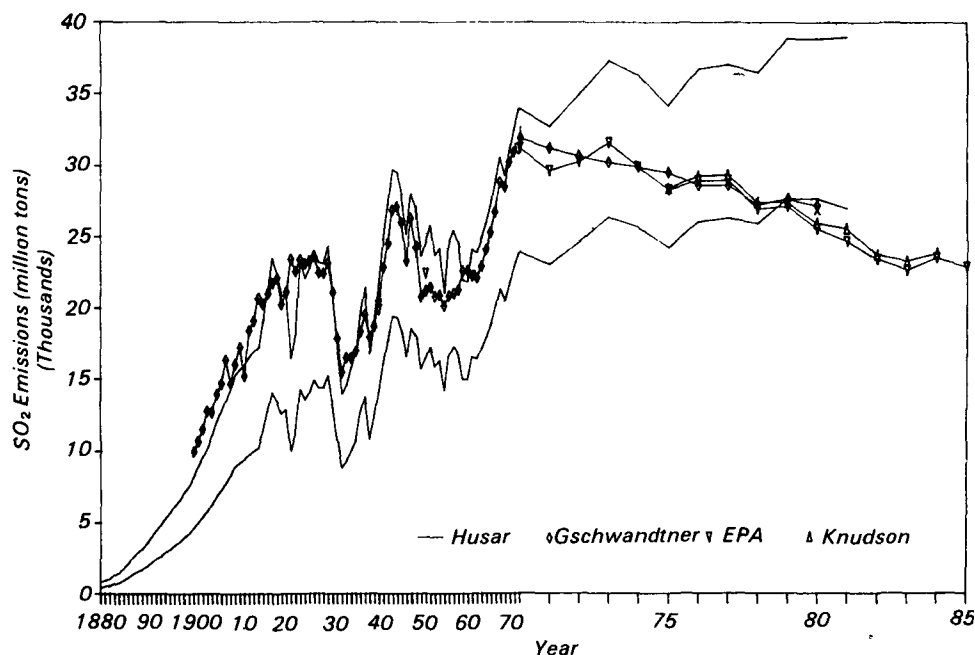


Figure 1. Comparison of total SO₂ emissions estimated by different studies.

3. The uncertainty methodology and the input data required for uncertainty estimation should be refined for application to the historic emissions inventory.
4. An analysis of the uncertainty associated with total national SO₂ emissions suggests that the uncertainty is primarily affected by uncertainty in coal sulfur content. Applying this preliminary uncertainty analysis to the methods used by Husar and Gschwandtner, as an illustrative example of uncertainty estimation, results in a calculated range of 31 to 45% uncertainty in these historic SO₂ emission estimates.

5. A similar analysis of the uncertainty associated with total national NO_x emissions suggests that this uncertainty is dominated by the uncertainty in historic NO_x emission factors. Applying this preliminary uncertainty analysis to the methods used by Husar and Gschwandtner, as an illustrative example of uncertainty estimation, results in a calculated range of 16 to 38% uncertainty in these historic NO_x emission estimates.
6. Because differing historic emission estimates have caused confusion among NAPAP researchers, the historical state-level emission estimates of Gschwandtner have been adjusted so that the aggregated total is identical to the U.S. EPA national emission

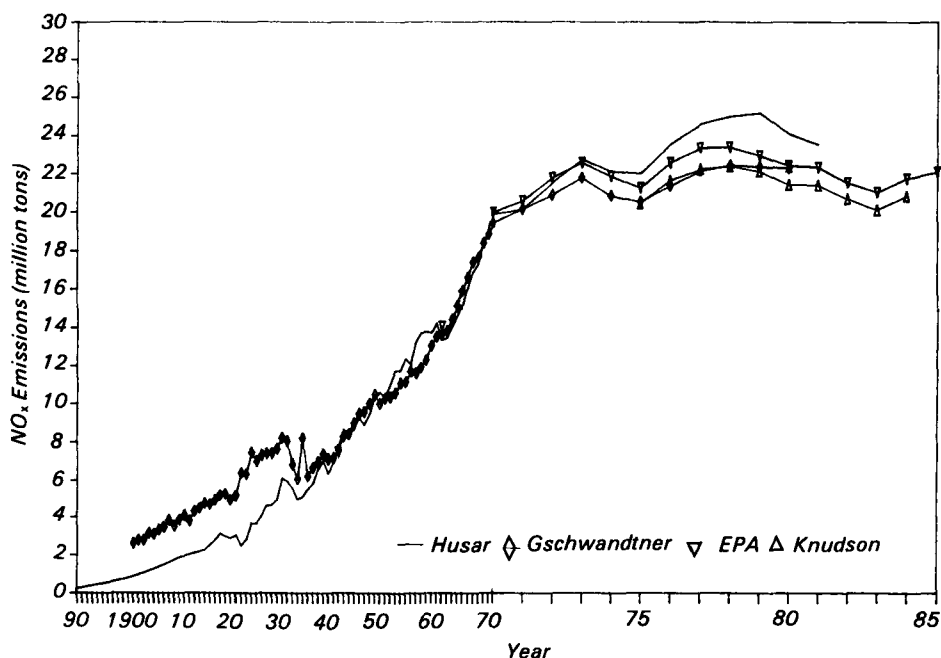


Figure 2. Comparison of total NO_x emissions estimated by different studies.

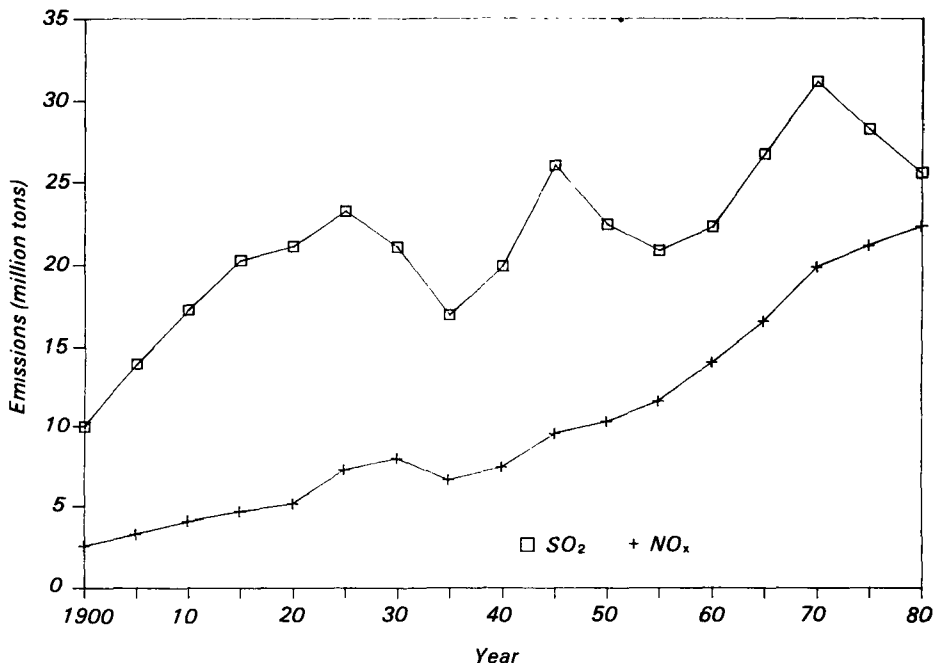


Figure 3. Revised SO₂ and NO_x historical emission estimates.

estimates, less states and territories outside the contiguous U.S.

7. For 1986, the U.S. EPA trends methodology was changed so that it accounts for the same FGD removal as the Pechan electric utility emission estimates. The revised methodology will also be applied to future years. For years before 1986, the national emission factors obtained from the Pechan inventories were incorporated in the trends calculations. As a result, the U.S. EPA trends for electric utilities and the Pechan estimates are identical.

8. The users of historic emissions data should understand the differing purposes of the various inventories and select the best inventory.

As a result of the present study, all emission inventories compared are in agreement regarding the total national emissions. While some differences have existed in the past regarding the exact quantity of total national emissions, the differences have been studied and adjustments have been made to yield a single annual national total emission estimate for NAPAP. As a result of this comparative study, the adjusted inventory presented in report Appendix A is recommended for use by NAPAP for the best estimates of long-range (back to 1900) annual emission trends.

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J. David Mobiey is the EPA Project Officer (see below).

The complete report, entitled "Comparison of Historic SO₂ and NO_x Emission Data Sets," (Order No. PB 89-103964/AS; Cost: \$19.95, subject to change); and a related diskette (Order No. PB 89-103956/AS; Cost \$75.00, subject to change) will be available only from:

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