United States
Environmental Protection
Agency

Air and Energy
Engineering Research Laboratory
Research Triangle Park NC 27711

Research and Development

EPA/600/S7-88/024 Mar. 1989

EPA

Project Summary

Documentation of Spatial Allocation Factor Procedures for the 1980 NAPAP Emissions Inventory

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Spatial allocation factors were developed to apportion NAPAP area source emissions from counties to individual grid cells for input to the Regional Acid Deposition Model (RADM) and Regional Oxidant Model (ROM). The development effort focused on creating a variety of spatial surrogates to allow the user maximum flexibility in assigning area source emissions to modeling grid cells. The surrogates are used to represent the subcounty distribution of area source emissions for each category. Fourteen surrogate indicators were developed for use with the NAPAP inventory based on housing, population, and land use data. Fortran programs were developed to generate the spatial factors. These programs are available on a companion magnetic tape. The user can specify processing options and grid definition by means of control options files accessed by the programs. Once the subcounty distribution of each surrogate is determined, area source emissions categories are matched to the most appropriate surrogate. The resultant Spatial Allocation Factor File is input to the Spatial Allocation Module of the Flexible Regional Emissions Data System.

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).

Background

The National Acid Precipitation Assessment Program (NAPAP) was established by Congress in 1980 to coordinate and expand research on problems posed by acid deposition in and around the U.S. The program is managed through the Interagency Task Force on Acid Precipitation which coordinates seven task groups having specific technical responsibilities. The Task Group on Emissions and Controls is charged with developing comprehensive and accurate inventories of emissions from sources thought to be important in acid deposition processes. To fulfill its objective and support other related NAPAP research, the Task Group on Emissions and Controls has generated a number of major emissions data bases using 1980 as the base year.

The primary focus of the 1980 NAPAP Emissions Inventory is the fulfillment of the emissions data requirements for developing and testing the Eulerian Regional Acid Deposition Model (RADM). In addition, emissions data are also used to support applications of the Regional Oxidant Model (ROM). To create emissions data suitable as model input, the 1980 Annual Inventory had to be resolved temporally, spatially, and by component species; allocation factors were developed to address these mod-

eling requirements. In addition, a data handling system was developed to create subsequent versions of the NAPAP Emissions Inventory. The Flexible Regional Emissions Data System (FREDS) for the 1980 NAPAP Emissions Inventory, consisting of five primary independent modules, was used to preprocess the 1980 NAPAP emissions data for input to the RADM.

Spatial allocation factors were developed to apportion area source emissions from counties to individual grid cells, 1/4° longitude by 1/6° latitude (approximately 20 x 20 km). The goal of the spatial allocation factor development effort was to create as many surrogate values as possible for each county, allowing the user maximum flexibility in assigning county-level emissions to specific grid cells. These surrogates are used to estimate the subcounty distribution of area source emissions.

Data used to estimate area source emissions for the NAPAP grid system are derived from diverse sources. Actual emissions or data from which emissions may be calculated (e.g., activity levels such as tons of coal sold or gasoline fuel consumption) are reported at the State and county level. Census data for population and housing are reported at various levels of geographic coverage, including subcounty levels. Land use data from satellite imagery and land use/cover maps were developed for a 1/4° longitude by 1/6° latitude grid. The land use by grid cell, however, required resolution relative to the county-level. Fortran programs were developed to assimilate the population, housing and land use data into county-level values and redistribute the information into spatial fractions (a spatial fraction is the fraction of a county's population, housing or land use contained within a specific grid cell).

Fourteen surrogate indicators were developed for use with the NAPAP inventory based on housing, population, and land use data. The categories and sources of data are summarized in Table 1. Once the subcounty distribution of each surrogate indicator is determined, area source emission categories are matched to the most appropriate surrogate indicators. For 1980 NAPAP application, 6 of the 14 surrogates are used for spatial allocation. The resultant Spatial Allocation Factor File (SAFF), is input to the Spatial Allocation Module (SAM) of the Flexible Regional Emissions Data System (FREDS) such that area source emissions may be spatially distributed among approximately 20 x 20 km grid cells.

SAM spatially resolves county-lev area source emissions to grid cells usir spatial allocation factors and a use defined grid. The grid boundaries ar cell size are input as control option SAM accepts an EBCDIC spatial fact file – the Spatial Allocation Factor Fi (SAFF) – output by the Spatial Allocatic Factor Preprocessor (SAFP), the fin program executed for the generation spatial factors. This file contains SC(state, county, column, row, and a spati surrogate value assigned to each recor Spatial allocation is accomplished b match-merging area source emissior records to those in the SAFF ar multiplying county-level area sourc emissions by their corresponding spati fractions.

Spatial Factor Overview

The development of spatial allocatic factors is based on two primary da sources: U.S. Department of Commerc Bureau of the Census, Census (Population and Housing (1980), and lar use/classification data derived fro 1972-1973 Landsat satellite image and land use/cover maps. Separa software was created to process th Census and Landsat data. Dat processing utilizes the National Comput

Table 1. *Spatial Allocation Surrogates Available in the NAPAP Spatial Allocation Factor File*

Surrogate Indicator No.	*Surrogate Indicator*	*Source*[a]
1	*Population*	*1980 Census*
2	*Housing*	*1980 Census*
3	*Urban Land*	*Landsat*[b]
4	*Agricultural Land*	*Landsat*
5	*Rangeland*	*Landsat*
6	*Deciduous Forest*	*Landsat*
7	*Coniferous Forest*	*Landsat*
8	*Mixed Forest and Forested Wetland*	*Landsat*
9	*Water*	*Landsat*
10	*Outside Study Area*	*Landsat*
11	*Non-forested Wetland*	*Landsat*
12	*Mixed Agricultural Land and Rangeland*	*Landsat*
13	*Composite Forest*	*Landsat*
14	*Land Area*	*EPA/Alliance*

[a] *National Acid Precipitation Assessment Program Emission Inventory Allocation Factors, EPA/600/7-85/035 (NTIS; PB86-104 247), September 1985.*

[b] *Landsat data are for 1971-1973.*

Center's (NCC) Sperry UNIVAC and IBM 3090.

The input data and Fortran programs, which are available on a companion magnetic tape, are summarized below:

- The *Bureau of the Census, Census of Population and Housing, 1980* is used to develop the census-based spatial allocation surrogates. This file consists principally of sample data expanded to represent the total population. Census data are summarized at the State level and are broken down in hierarchical sequence to more specific geographic levels such as block groups and enumeration districts.

- The *Landsat and land use/cover data*, in conjunction with county-grid area relationships are used to derive land use specific spatial allocation factors. The land use/cover data base was developed using Landsat mosaic images covering the periods July 23 to October 31, 1972 and January 1 to March 31, 1973, and Land Use and Land Cover maps developed in the middle-to-late 1970's. Land use/cover percentages for 1/4° longitude by 1/6° latitude grid cells are reported for the following categories: urban land, agricultural land, rangeland, deciduous forest land, coniferous forest land, mixed agricultural land and rangeland, mixed forest land, water, barren land, and non-forested wetland.

- The *CREATE7A* program condenses and reformats the census files, substitutes NEDS for FIPS codes, and calculates sub-county fractions of housing and population. The program input includes the state-specific census of population and housing data, a control options file, the FIPS to NEDS conversion file, and the Massachusetts Update File (used to process data relative to Air Pollution Control Districts instead of counties). This program is executed on the Sperry UNIVAC.

- The *CREATE5A* program generates county-to-grid allocation files for each State output by CREATE7A. Allocation files may be created for up to 11 surrogate categories. In addition to the condensed census file output by CREATE7A, a user-defined control options file is input to CREATE5A. This program is also executed on the Sperry UNIVAC.

- The program *VIRGINIA* is executed for the State of Virginia to adjust the census data for the state's independent cities. Of the 41 independent cities, 31 are considered by CREATE5A to be separate from their respective counties, although both possess the same NEDS ID. VIRGINIA merges the data by NEDS code, combining identical rows and columns, and adjusting corresponding county totals. Virginia is executed on Sperry UNIVAC.

- The *NEWLAND* program reads and processes the land use and land cover data. The main function of the program is to convert the land use data, reported as the percent of each grid occupied by each land use category, into the fraction of each county's land use assigned to each grid cell. Two input files are required to process the data: land use percentages and county-to-grid fractions. Two additional categories are calculated in NEWLAND: composite forest land and land area. Newland is also executed on the Sperry UNIVAC.

- The program *SPACEMERGE*, executed on the Sperry, reads spatial fractions generated from the land use and census data and match merges each record by NEDS ID, column number, and row number. In addition, SPACEMERGE checks for Massachusetts' records such that land use fractions, based on county areas, may be converted to land use fractions by Air Pollution Control Districts.

- The *Spatial Allocation Factor Preprocessor (SAFP)* creates spatial allocation factors which are compatible with the SAM of FREDS. The main function of the program is to match the spatial fractions output by SPACEMERGE to area source categories by means of a user-defined surrogate selection file. Three input files are accessed by SAFP: the control file, the surrogate selection file, and the spatial fractions. In addition, SAFP performs quality control checks on the input spatial fractions.

Conclusions

This report documents the software used to generate spatial allocation factors used in the development of the resolved 1980 NAPAP emissions inventory. The Fortran programs contained in the document and on magnetic tape support the spatial resolution requirements of acid deposition and photochemical oxidant models. The availability of the spatial factor software documentation and magnetic tape allow use of this methodology by all inventory users. In addition, documentation of the programs in accordance with EPA's automatic data processing standards ensures their usefulness for future applications.

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***J. David Mobley** is the EPA Project Officer (see below).*
The complete report consists of paper copy and magnetic tape, entitled "Documentation of Spatial Allocation Factor Procedures for the 1980 NAPAP Emissions Inventory,"
Paper Copy (Order No. PB 89-159 479/AS; Cost: $28.95)
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