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Regional Air Pollution Study, Emission Inventory Summarization

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Regional Air Pollution Study

Emission Inventory Summarization

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This report has been assigned to the ENVIRONMENTAL MONITORING series. This series describes research conducted to develop new or improved methods and instrumentation for the identification and quantification of environmental pollutants at the lowest conceivably significant concentrations. It also includes studies to determine the ambient concentrations of pollutants in the environment and/or the variance of pollutants as a function of time or meteorological factors.

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ABSTRACT

As part of the Regional Air Pollution Study (RAPS), data for an air pollution emission inventory are summarized for point and area sources in the St. Louis Air Quality Control Region. Data for point sources were collected for criteria and non-criteria pollutants, hydrocarbons, sulfur trioxide, particle size distribution, and heat. For area sources, data were collected on criteria pollutants, hydrocarbons and heat.

All the data have been entered into the RAPS Data Bank. Hourly values are available for all point sources; locations are identified by UTM coordinates (zone 15) to within ±10 m. Area sources are assigned to a network of 1989 grid squares of variable size. The emission inventory is applicable for the years 1975 and 1976 and complements the RAPS aerometric data.

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1.0 INTRODUCTION

1.1 THE REGIONAL AIR POLLUTION STUDY (RAPS)

The Regional Air Pollution Study (RAPS) was conceived early in 1970 to provide a rational, scientific basis for the management of air quality, as mandated by the Clean Air Act (as amended). The basic premise of the Act is that desired air quality standards can be obtained by setting appropriate emission standards. The development of Implementation Plans, called for by the Act, assumes that existing knowledge was at least minimally adequate for planning.

The basic tool for the development of air quality management is the simulation model, a mathematical description of the complex relationship between emissions, atmospheric dispersion and transformation, and ambient concentration. The development of any model presupposes: 1) a detailed understanding of the physical, chemical and meteorological process involved, and 2) availability of adequate emission data, meteorological information and measurements of ambient concentrations of the pollutants under investigation.

At the beginning of the RAPS study, a number of simulation models had been developed, but few--if any--had been verified in the field. The primary reason for this was the absence of an adequate data base, which would contain accurate, high resolution data covering a sufficiently large area. Ambient data were available with adequate time resolution--one hour or less--but the stations providing such data were typically too few and improperly spaced to cover a given area. Meteorological data were usually available only at very few points in a given area, such as an airport, where they were gathered for other purposes. Micrometeorological data related directly to ambient measurements were generally unavailable.

Emission inventories have been in existence for some years, and owing to the efforts of the National Air Data Branch of OAQPS, were being collected in a uniform, machine readable format known as National Emission Data System

(NEDS). However, the NEDS inventory contained essentially only annual data, which cannot readily and reliably be converted to hourly values over the two year RAPS program period.

Clearly, what was needed as a first step in the development of a rational approach to the management of air pollution was an extensive, detailed data base containing all these elements: emission, meteorological, and ambient data, with a resolution in time and space and an accuracy adequate to provide an input to simulation models. This became the first task of RAPS. (1)

The St. Louis Interstate Air Quality Control Region (AQCR 70) was chosen as the site for RAPS (Figure 1). The selection was based on the need to find a large city within the continental United States, which was away from oceans and mountains and which typified the coal-burning industrial nature of many urban areas, yet which lay in an extended region of rural country. Of the 33 Standard Metropolitan Statistical Areas larger than 400,000 population, St. Louis emerged as the clear choice based on the following criteria:

- Surrounding Area
- Heterogeneous Emissions
- Area Size
- Pollution Control Program
- Historical Information
- Climate

1.2 THE RAPS EMISSION INVENTORY

The emission inventory is an integral part of RAPS. With the network of Regional Air Monitoring Stations (RAMS) gathering minute-by-minute ambient and micrometeorological data (Figure 2), an emission inventory of equal quality was needed. Practical considerations make time intervals of less than one hour unrealistic. It was desirable to have the emission data based on measured values rather than calculated ones. Initially the principal pollutant of interest to the modelers was SO_2, which is intimately associated with stationary (combustion) sources.

Thus, the initial thrust was to develop a detailed point source inventory for SO_2, based on hourly, measured values. It became quickly apparent that the distribution of sources in the St. Louis AQCR made this technically feas-

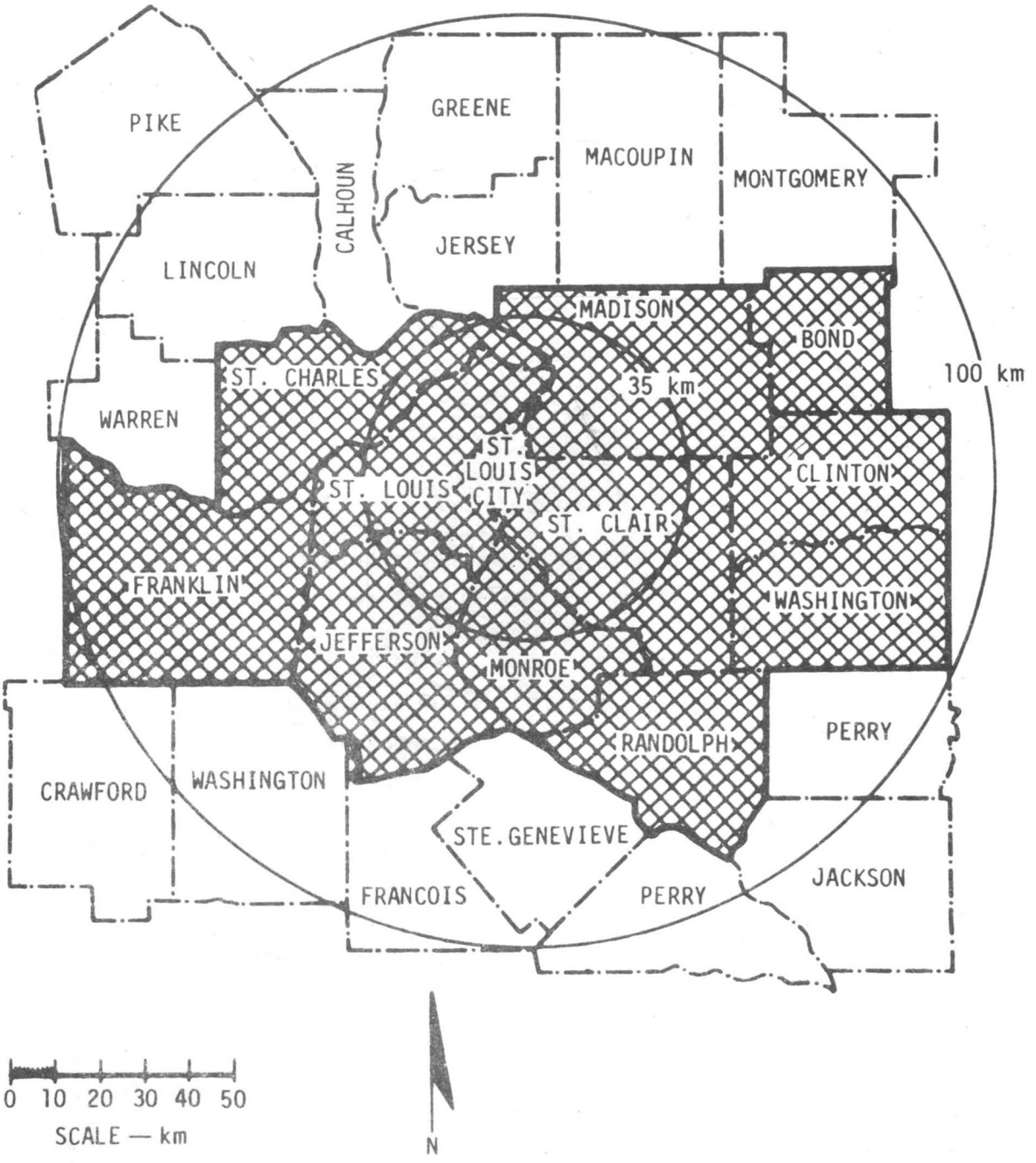


FIGURE 1. METROPOLITAN SAINT LOUIS INTERSTATE AIR QUALITY CONTROL REGION (SHADED AREAS ARE INCLUDED IN THE AQCR)

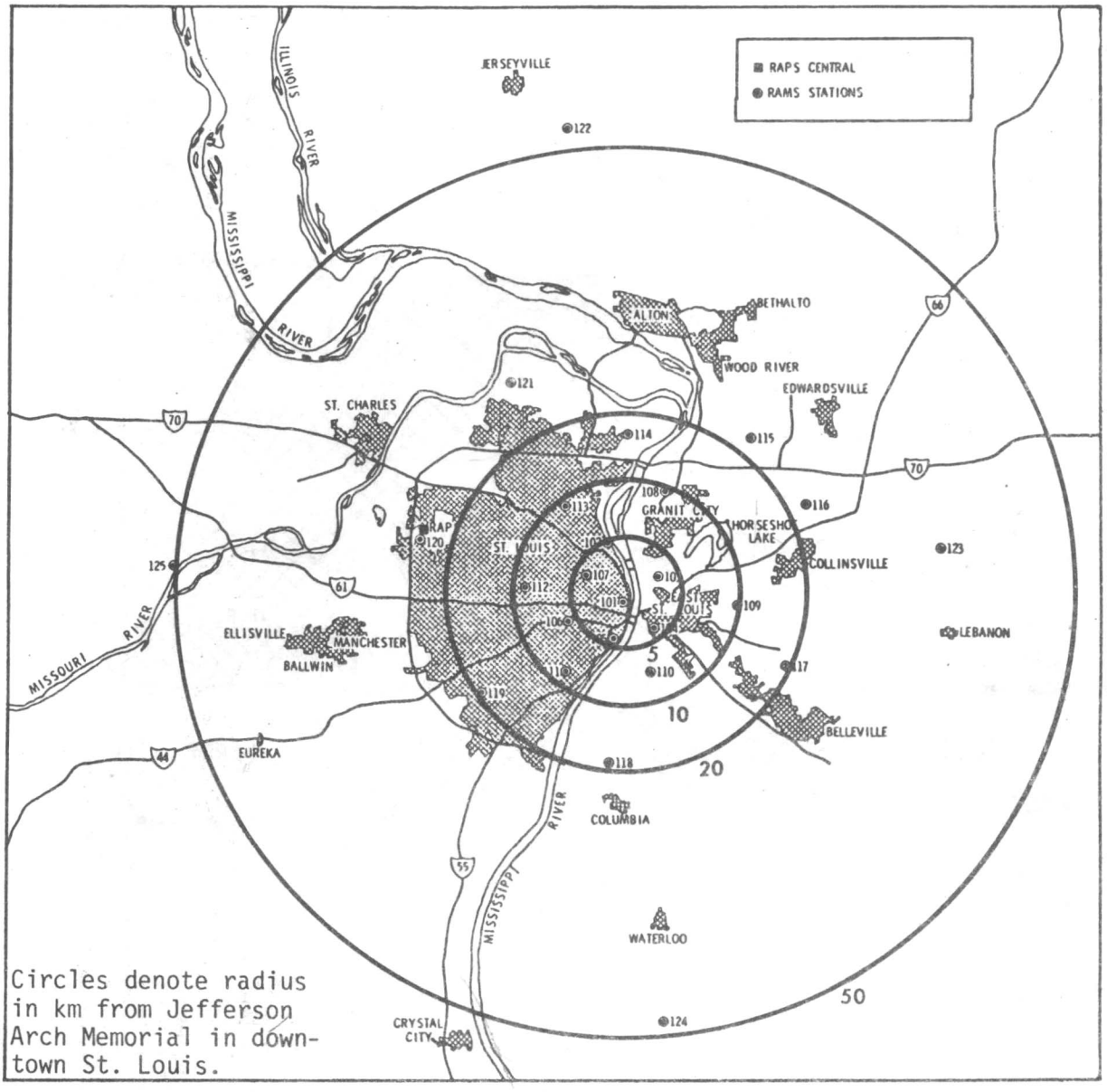


FIGURE 2. THE REGIONAL AIR MONITORING STATIONS NETWORK

ible, since a relatively small number of large sources (emitting more than 1000 tons of SO_2 annually) accounted for well over 90 percent of all emissions (Figure 3).

Arrangements were made with the companies involved to obtain the necessary data for 1975 and 1976. The data collected were not usually mass emissions of SO_2, but rather fuel consumption or production data, from which SO_2 emissions were calculated. There were several reasons for this arrangement:

1) Fuel consumption data are usually quite accurate and readily obtainable.

2) The amount of sulfur in fuel is a direct measure of SO_2 produced.

3) The emission factors for SO_2 were quite reliable.

4) Other emissions can be calculated from the same base data.

As time progressed, inventories for other pollutants were added. At this point, the following inventory data are available for the St. Louis area:

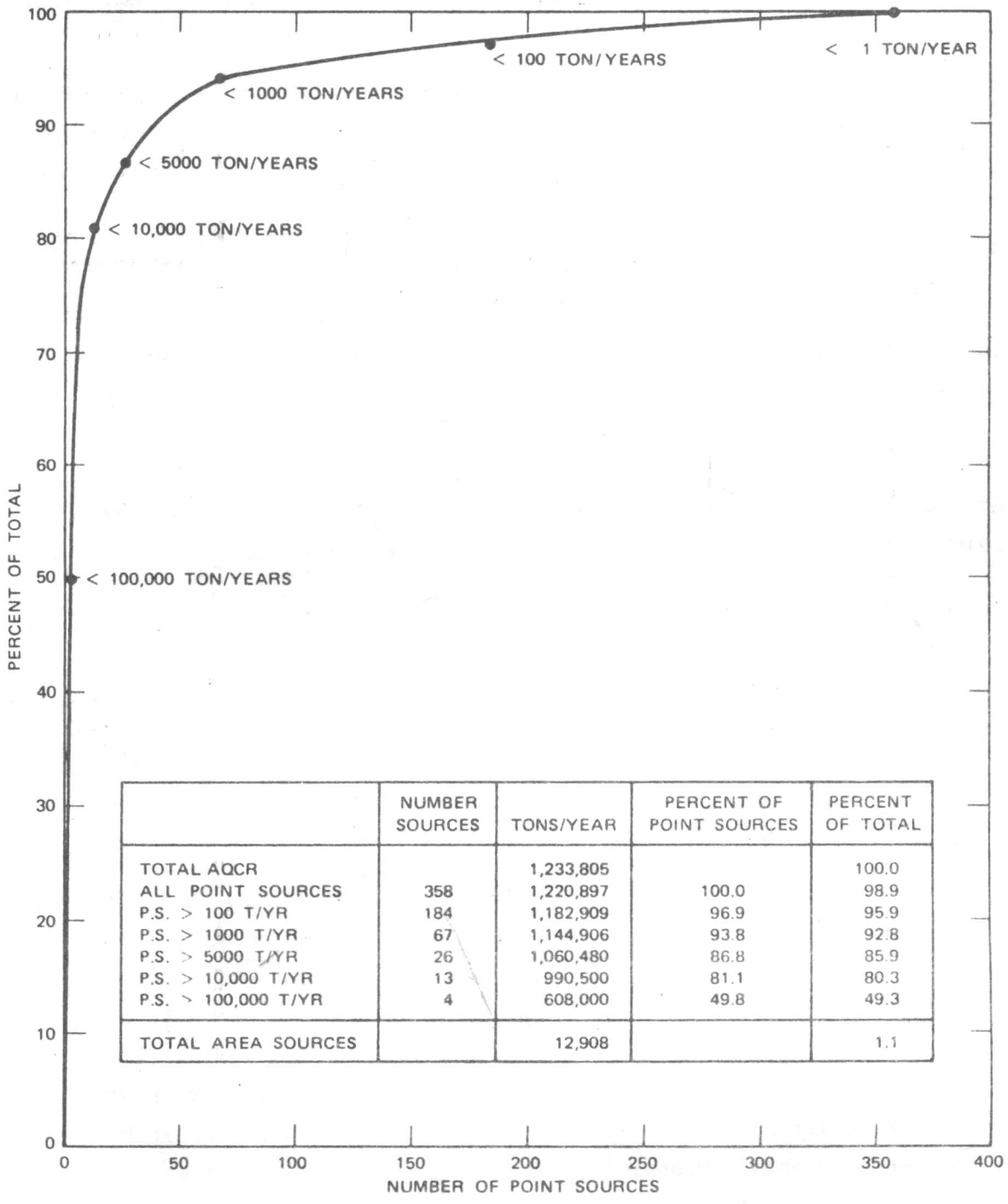
A. Point Sources

1) Criteria Pollutants - TSP, SO_2, NO_x, THC, CO
2) Hydrocarbon breakdown
3) Non-Criteria Pollutants
4) Heat
5) Sulfur trioxide
6) Particle Size Distribution

B. Area Sources

1) Criteria Pollutants - TSP, SO_2, NO_x, THC, CO
2) Hydrocarbon Breakdown
3) Heat

As a first step, a parametric study was conducted to determine the most desirable characteristics of an emission inventory gathered for research (rather than enforcement) purposes (2). The study recommended that measured, rather than calculated data be used to the largest extent possible; determined the potential uses and users of the inventory and their expected requirements; proposed a methodology for developing an inventory of the desired quality;



	NUMBER SOURCES	TONS/YEAR	PERCENT OF POINT SOURCES	PERCENT OF TOTAL
TOTAL AQCR		1,233,805		100.0
ALL POINT SOURCES	358	1,220,897	100.0	98.9
P.S. > 100 T/YR	184	1,182,909	96.9	95.9
P.S. > 1000 T/YR	67	1,144,906	93.8	92.8
P.S. > 5000 T/YR	26	1,060,480	86.8	85.9
P.S. > 10,000 T/YR	13	990,500	81.1	80.3
P.S. > 100,000 T/YR	4	608,000	49.8	49.3
TOTAL AREA SOURCES		12,908		1.1

SOURCE: NEDS Inventory (1973).

FIGURE 3. SO_2 EMISSIONS FOR THE SAINT LOUIS AIR QUALITY CONTROL REGION

suggested a data handling system; and reviewed existing emission data for St. Louis and emission models relevant to the objectives of RAPS. Cumulative plots of the number of sources vs. percent of total emissions for individual components were particularly useful in visualizing the scope of the problem at St. Louis, as was the critical review of existing emission models. A parametric examination of the effect of source location error also proved useful in designing the inventory.

2.0 POINT SOURCE EMISSION INVENTORY

2.1 DEFINITION

For the Regional Air Pollution Study, point sources were defined initially as sources emitting on the order of 0.01 percent of the total emissions of a pollutant for the whole AQCR. As a result, point sources were considered to be in excess of 100 tons per year for SO_2, 25 tons per year for particulates, 10 tons per year for CO, 30 tons per year for NO_X and 10 tons per year for hydrocarbons. In all, data were obtained from 574 sources.

TABLE 1. TOTAL EMISSIONS FOR THE ST. LOUIS AQCR (TONS PER YEAR)

	Particulates	SO_2	NO_X	HC	CO
Point Sources (% of Total)	45,224 (3%)	1,007,530 (97%)	322,730 (72%)	47,610 (23%)	164,331 (11%)
Area Sources (% of Total)	1,299,782 (97%)	30,813 (3%)	125,567 (28%)	157,204 (77%)	1,325,556 (89%)
Total	1,345,006	1,038,334	448,297	204,814	1,489,887

For the initial (SO_2) inventory, point sources were further classified into major (> 1000 tons per year) and minor (between 100 and 1000 tons per year) sources. Actual hourly emission data were collected for the major sources only. Since the preliminary survey suggested that the major sources emitted well over 90 percent SO_2, that seemed quite adequate. The actual breakdown of hourly point sources is shown in Table 2.

TABLE 2. SUMMARY OF HOURLY SOURCE DATA

Companies	Locations	Sources of Pollutants					
		PART.	SO_2	NO_X	HC	CO	HEAT
14	22	113	146	113	113	82	113