Chapter 7

Metropolitan Area Trends

WHILE MOST OF this report discusses air quality trends on a national scale, there is interest in information about local air quality. This chapter presents status and trends in criteria pollutants for MSAs in the United States. A complete list of MSAs and their boundaries can be found in the *Statistical Abstract of the United States*.[1] The status and trends of metropolitan areas are based on four tables found in Appendix A (A-14 through A-17). Table A-14 gives the 1996 peak statistics for all MSAs, providing the status of the most recent year. Ten-year trends are shown for the 258 MSAs having data that met the trends criteria explained in Appendix B. Table A-15 lists these MSAs and reports criteria pollutant trends as "upward" or "downward," or "not significant." These rankings are based on a statistical test, known as the Theil test, which is described later in this chapter. Another way to assess trends in MSAs is to examine PSI values.[2,3] The PSI is used to combine daily information on one or more criteria pollutants into an easily understood format, which can then be presented to the public in a timely manner. Tables A-16 and A-17 list the number of days with PSI values greater than 100 (unhealthful) for the nation's 94 largest metropolitan areas (population greater than 500,000). Table A-16 lists PSI values based on all pollutants while Table A-17 lists PSI values based on ozone alone.

All MSAs do not appear in these tables because of the availability of data or the size of the MSA. There are MSAs with no ongoing air pollution monitoring because these areas do not have pollution problems. The same is true for certain combinations of MSAs and pollutants. There are also MSAs with so little information that the criteria for trends analysis are not met (see Appendix B). Finally, there are MSAs that do not meet size criteria for certain tables and, therefore, are not included.

Status: 1996

The air quality status for MSAs can be found in Table A-14 (for related information, see Table A-11—peak concentrations for all counties with monitors that reported to the AIRS data base). Table A-14 lists peak statistics for all criteria pollutants measured in an MSA. Since certain areas are not considered to have a problem with all criteria pollutants, all criteria pollutants are not measured in all MSAs and, therefore, are designated as "ND" (no data) for those pollutants. Examining Table A-14 shows that 45 areas had peak concentrations from at least one criteria pollutant exceeding standard levels. These areas represent 27 percent of the U.S. population. Similarly, there were 10 areas representing 10 percent of the population that had peak statistics that exceeded two or more standards. Only one area, (Philadelphia, PA) representing 2 percent of the U.S. population, had peak statistics from three pollutants that exceeded the respective standards. High values for two pollutants, PM_{10} and lead, are due to one localized industrial source. There were no areas, however, that violated four or more standards. In fact, 1996 was the fifth year in a row that there were no violations of the NO_2 standards in the United States.

Trends Analysis

Air quality trends for MSAs are examined in Table A-15. The data in this table are based on pollutant concentrations from the subset of ambient monitoring sites that meet the same trends criteria explained in Appendix B. A total of 258 MSAs had at least one monitoring site that met these criteria. As stated previously, not all pollutants are measured in every MSA.

From 1987 to 1996, statistics based on the NAAQS were calculated for each site and pollutant with available data. Spatial averages were obtained for each of the 258 MSAs by averaging these statistics across all sites in an MSA. This process resulted in one value per MSA per year for each pollutant. Although there are seasonal aspects of certain pollutants and, therefore, seasonality in monitoring intensity among MSAs, the averages for every MSA and year provide a consistent value with which to assess trends.

To assess upward or downward trends, a linear regression was applied to these data. Since the underlying pollutant distributions do not meet the usual assumptions required for common least squares regression, the regression analysis was based upon a nonparametric method commonly referred to as the Theil test.[4,5,6] Because linear regression estimates the trend from changes during the entire 10-year period, it is possible to detect an upward or downward trend even when the concentration level of the first year equals the concentration level of the last year. Because this method uses a median estimator, it is not influenced by single extreme values. Since air pollution levels are affected by variations in meteorology, emissions, and day-to-day activities of populations in MSAs, trends in air pollution levels are not always well defined. Another advantage of using the regression analysis is the ability to test whether or not the upward or downward trend is real (significant) or just a chance product of year-to-year variation (not significant).

Table 7-1 summarizes the trend analysis performed on the 258 MSAs. It shows that there were no upward trends in CO, lead, and PM_{10} (annual mean) at any of the MSAs over the past decade. Of the 258 MSAs, 217 had downward trends in at least one of the criteria pollutants, and only 13 had upward trends. A closer look at these 13 MSAs reveals that all are well below the NAAQS for the respective pollutant, meaning that their upward trends are not immediately in danger of violating the NAAQS (in fact, none of these areas are classified as nonattainment for a NAAQS). These results demonstrate significant improvements in urban air quality over the past decade.

Table 7-1. Summary of MSA Trend Analysis, by Pollutant

		Total # MSAs	# MSAs Up	# MSAs Down	# MSAs with No Significant Change
CO	Second Max, 8-hour	140	0	99	41
Lead	Max Quarterly Mean	95	0	76	19
NO_2	Arithmetic Mean	90	2	50	38
Ozone	Second Daily Max, 1-hour	192	1	51	140
PM_{10}	Second Max, 24-hour	216	6	96	114
PM_{10}	Weighted Annual Mean	216	0	153	63
SO_2	Arithmetic Mean	143	4	98	41
SO_2	Second Max, 24-hour	143	4	79	60

The Pollutant Standards Index

PSI values are derived from pollutant concentrations. They are reported daily in all metropolitan areas of the United States with populations exceeding 200,000, and are used to report air quality over large urban areas. The PSI is reported as a value between zero and 500 or a descriptive word (e.g., "unhealthful") and is featured on local TV or radio news programs and in newspapers.

Based on their short-term NAAQS, Federal Episode Criteria,[7] and Significant Harm Levels,[8] the PSI is computed for PM_{10}, SO_2, CO, O_3, and NO_2. Lead is the only criteria pollutant not included in the index because it does not have a short-term NAAQS, a Federal Episode Criteria, or a Significant Harm Level. Since the PSI is a tool used to communicate pollution concerns to a wide audience, there are also colors linked to the general descriptors of air quality. The five PSI color categories and their respective health effects descriptors are listed in Table 7-2.

The PSI integrates information on criteria pollutant concentrations across an entire monitoring network into a single number that represents the worst daily air quality experienced in an urban area. For each of the criteria pollutants, concentrations are converted into an index value between zero and 500. The pollutant with the highest index value is reported as the PSI for that day. Therefore, the PSI does not take into account the possible adverse effects associated with combinations of pollutants (i.e., synergism).[2,3]

A PSI value of 100 corresponds to the standard established under the CAA. A PSI value greater than 100 indicates that at least one criteria pollutant (with the exception of NO_2) exceeded the level of the NAAQS, therefore designating air quality to be in the unhealthful range on that day. Relatively high PSI values activate public health warnings. For example, a PSI of 200 initiates a First Stage Alert at which time sensitive populations (e.g., the elderly and persons with respiratory illnesses) are advised to remain indoors and reduce physical activity. A PSI of 300 initiates a Second Stage Alert at which time the general public is advised to avoid outdoor activity.

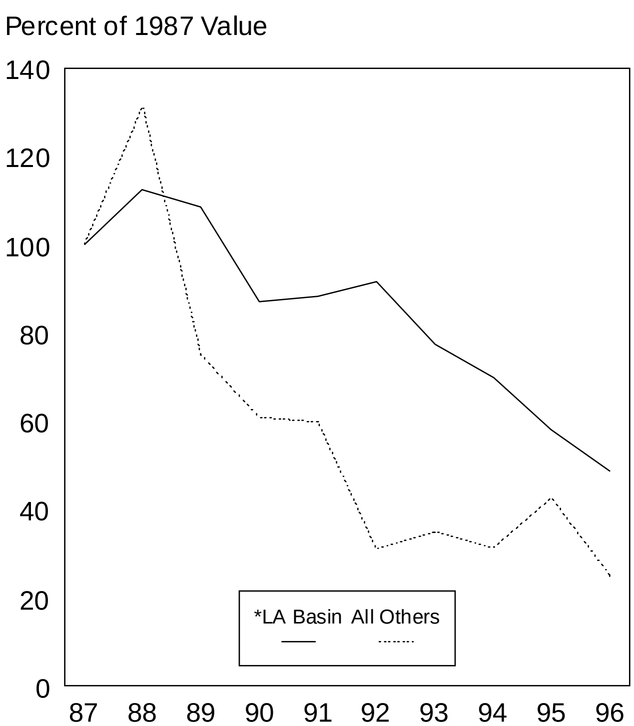
Summary of PSI Analyses

Of the five criteria pollutants used to calculate the PSI, CO, O_3, PM_{10}, and SO_2 generally contribute to the PSI value. Nitrogen dioxide is rarely the

Table 7-2. Pollutant Standards Index Values with Pollutant Concentration, Health Descriptors, and PSI Colors

INDEX VALUE	AIR QUALITY LEVEL	POLLUTANT LEVELS PM-10 (24-hour) $\mu g/m^3$	SO_2 (24-hour) $\mu g/m^3$	CO (8-hour) ppm	O_3 (1-hour) ppm	NO_2 (1-hour) ppm	HEALTH EFFECT DESCRIPTOR	PSI COLORS
500	SIGNIFICANT HARM	600	2,620	50	0.6	2.0		
400	EMERGENCY	500	2,100	40	0.5	1.6	HAZARDOUS	RED
300	WARNING	420	1,600	30	0.4	1.2		
							VERY UNHEALTHFUL	ORANGE
200	ALERT	350	800	15	0.2	0.6		
							UNHEALTHFUL	YELLOW
100	NAAQS	150	365	9	0.12	a		
							MODERATE	GREEN
50	50% OF NAAQS	50	80[b]	4.5	0.06	a		
							GOOD	BLUE
0		0	0	0	0	a		

[a] No index values reported at concentration levels below those specified by "Alert Level" criteria.
[b] Annual primary NAAQS.



* Los Angeles, CA
Riverside, CA

Figure 7-1. Number of days with PSI values > 100, as a percentage of 1987 value.

highest pollutant measured because it does not have a short-term NAAQS and can only be included when concentrations exceed one of the Federal Episode Criteria or Significant Harm Levels. Ten-year PSI trends are based on daily maximum pollutant concentrations from the subset of ambient monitoring sites that meet the trends criteria in Appendix B.

Since a PSI value greater than 100 indicates that the level of the NAAQS for at least one criteria pollutant has been exceeded on a given day, the number of days with PSI values greater than 100 provides an indicator of air quality in urban areas. Figure 7-1 shows the trend in the number of days with PSI values greater than 100 summed across the nation's 94 largest metropolitan areas as a percentage of the 1987 value. Because of their magnitude, PSI totals for Los Angeles, CA and Riverside, CA are shown separately as the LA Basin. Plotting these values as a percentage of 1987 values, allows two trends of different magnitudes to be compared on the same graph. The long-term air quality improvement in urban areas is evident in this figure. Between 1987 and 1996, the total number of days with PSI values greater than 100 decreased 51 percent in the Los Angeles Basin and 75 percent in the remaining major cities across the United States.

PSI estimates depend on the number of pollutants monitored as well as the number of monitoring sites where data are collected. The more pollutants measured and sites that are available in an area, the better the estimate of the maximum PSI for a given day. Ozone accounts for the majority of days with PSI values above 100, but is collected at only a small number of sites in each area. Table A-18 shows that the percentage of days with PSI values greater than 100 that could be attributed to ozone alone has increased from 78 percent in 1987 to 89 percent in 1996. This increase reveals that ozone increasingly accounts for those days above the 100 level and reflects the success in achieving lower CO and PM_{10} concentrations. However, the typical one-in-six day sampling schedule for most PM_{10} sites limits the number of days that PM_{10} can factor into the PSI determination.

The PSI is currently undergoing revision to reflect the changes in the ozone and PM NAAQS. These revisions will be proposed in the Spring of 1998 and should be finalized by the end of 1998. Concurrently, the Federal Episode Criteria and Significant Harm Levels for ozone and PM are being revised to reflect the health effects data that motivated the revisions to the ozone and PM NAAQS.

References

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2. Measuring Air Quality, The Pollutant Standards Index, EPA-451/K-94-001, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, February 1994.
3. *Code of Federal Regulations*, 40 CFR Part 58, Appendix G.
4. T. Fitz-Simons and D. Mintz, “Assessing Environmental Trends with Nonparametric Regression in the SAS Data Step,” American Statistical Association 1995 Winter Conference, Raleigh, NC, January, 1995.
5. Freas, W.P. and E.A. Sieurin, “A Nonparametric Calibration Procedure for Multi-source Urban Air Pollution Dispersion Models,” presented at the Fifth Conference on Probability and Statistics in Atmospheric Sciences, American Meteorological Society, Las Vegas, NV, November 1977.
6. M. Hollander and D.A. Wolfe, *Nonparametric Statistical Methods*, John Wiley and Sons, Inc., New York, NY, 1973.
7. *Code of Federal Regulations*, 40 CFR Part 51, Appendix L.
8. *Code of Federal Regulations*, 40 CFR Part 51, section 51.151.