Air Monitoring and Health Data Needed in Southern Indiana

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Purpose of Study

The purpose of this study was multiple: 1) to determine the air-pollution-related diseases; 2) to determine the disease-related air pollutants; 3) to plot the geographic distribution of air-pollution-related diseases in Southern Indiana; 4) to plot the geographic distribution of disease-related air pollutants in southern Indiana; 5) to make recommendations for corrective measures where unusually high concentrations of air-pollution-related diseases or disease-related air pollutants are found.

Literature Survey

A World Library Search of 319,000 citations concerning diseases related to air pollutants was conducted through Dialog Service, a division of Lockheed Aircraft, Palo Alto, CA. This computer search was designed to reveal both positive and negative correlations between air pollutants and human disease. However, no scientific studies were found that refute the numerous studies indicating that air pollution is harmful to human health. Examination of research abstracts revealed a close relationship between air pollution levels and diseases of the circulatory and respiratory systems in humans.

Several authors have found that alterations in human health were most likely attributed to exposure to sulfur dioxide, sulfuric acid, and acid sulfates. (2) Deaths from cardiovascular disease showed a close association with sulfate pollution. (9) At a National Symposium, Fairchild pointed out that numerous epidemiologic studies conducted in the United States, Great Britain and Japan have demonstrated that under certain conditions sulfur dioxide and suspended particulate matter are associated with increased occurrence of disease, usually respiratory or cardiovascular disease. Some studies have shown that health effects are more closely correlated with total suspended soluble sulfate than with sulfur dioxide alone. (4)

Tzukamoto, Serizawa and Akita (15) found a close connection between the monthly morbidity and average concentration of sulfur dioxide and nitrogen dioxide in the air. Further, the weekly average morbidity of cold symptoms showed a correlation to weekly average concentration of sulfur dioxide and nitrogen dioxide, even when the concentration of sulfur dioxide was less than 0.04 ppm (105 $\mu g/m^3$) (average 24 hour), which is the Japanese National Standard. Another Japanese study conducted in the cities of Yokkaichi and Tsu confirmed that the morbidity of acute respiratory disease such as cold decreased

with a decrease of air pollution. The study showed that in younger people, morbidity of asthma-type diseases decreased, showing the effect of decrease of air pollution. (7)

Some scientists believe that air pollution may lead to the increase in cancer rates. Researchers at the University of California at Davis have recently established that fly ash and particulates from coal-fired power plants are mutagenic in the Ames Test and, thus, a likely carcinogen. (1) There is also the possibility that increased levels of nitrogen dioxide in the atmosphere could lead to increased cancer rates. Nitrogen dioxide is the precursor of nitrates and may play a role in the atmospheric formation of nitrosamines, one of the most potent classes of carcinogens yet uncovered. Because control technology is in its infancy, scientists now predict that nitrogen dioxide levels will skyrocket in the next ten years. (1) The already increasing levels of nitrogen and sulfur oxides have led to acid rainfalls in the northeast. (12)

Epidemiological studies are very difficult to conduct. There always seems to be one or more variables that are difficult to control. Ferris and his coworkers have made the wise suggestion that it is from children the most valuable information may come, since the true effects of air pollution should not, theoretically, be masked by other environmental factors such as occupational exposure and smoking. (5)

It is of utmost importance that the results of these studies be taken seriously. Air pollution not only affects our health but also our economy. Most studies that are nationwide in scope calculate the annual damages of air pollution in the billions of dollars. (6) These vexing problems are further complicated by the coexistence of differing economic and moral values within our society.

The literature search revealed that the diseases most often correlated with air pollution are heart, cerebrovascular, arteries, emphysema, cancer and pneumonia. The air pollutants most often correlated with these types of cardiovascular and respiratory diseases are sulfur dioxide, sulfuric acid, sulfates, suspended particulates, nitrogen oxides, certain hydrocarbons, radioactive substances, carbon monoxide, ozone and heavy metals.

Pollution Studies Concerning Southern Indiana

National studies conducted by the United States Environmental Protection Agency and Dr. Hugh Spencer, University of Louisville, were examined concerning the growing threat of air pollution (particularly sulfates) in the Eastern United States. This is of particular concern in the Ohio River Valley, where coal-fired power generation is a growing threat to human health. Results of these studies indicate the following:

Visibility has decreased steadily in the Eastern United States during the past 25 years. (13) Sulfate levels in the Eastern United States have been steadily rising with increased coal use since 1953. Noticeable health effects to humans occur at sulfate levels as low as 6-10 $\mu g/m^3$. In 1974 the airborne sulfate concentrations in Southwestern

Indiana ranged from 10-14 $\mu g/m^3$ and in Southeastern Indiana they were above 15 $\mu g/m^3$. Four studies have shown that at sulfate levels of 6-10 $\mu g/m^3$ (24 hour exposure) increased asthma attacks occur; at levels greater than 13 $\mu g/m^3$ (several years exposure) increased acute respiratory diseases in children occur. Sulfate levels in the Ohio River Valley (already the summer air pollution capital of the U.S. according to the U. S. E. P. A.) are projected by workers at Brookhaven Laboratories to be 28 $\mu g/m^3$ by 1990, if the present increase in coal use continues as planned. (10) At sulfate levels above 25 $\mu g/m^3$ excessive deaths can be expected.

Acid rains are increasing in frequency in the midwest and northeast United States as sulfur oxide (SO_X) and sulfate levels continue to rise throughout this region. The acidity of the rainfall in Southern Indiana has increased more than ten-fold over a period of sixteen years. (3) Some fish kills in lakes in the Adirondak Mountains of New York have been attributed by the U. S. E. P. A. to industrial activity in the Midwest. Increased sulfate levels, reduced visibility and acid rains all result from sulfur oxide emissions.

The principal source of these emissions is coal combustion in power generation as indicated in Table 1.

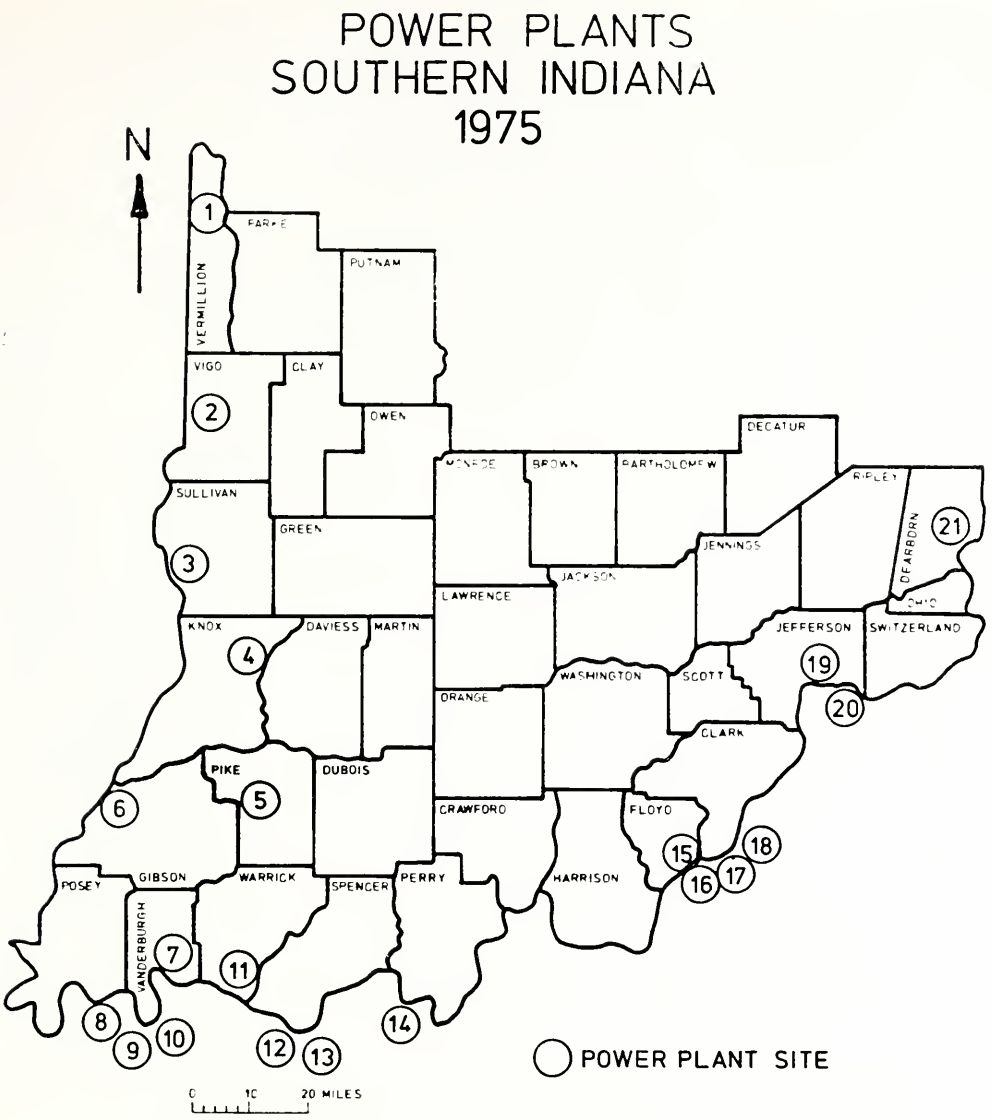
TABLE 1. *Principal sources of sulfur oxides 1975 (3)*

	% of Total
Electric Utilities	64
Industrial Processes	17
Industrial Fuel	15
Other	4
Total	100

Power plant locations in southern Indiana are indicated on Figure 1. This pattern of power plant distribution corresponds with high density sulfur dioxide concentrations indicated by scientists conducting research for the Ohio River Basin Energy Study. (14) County sulfur dioxide emissions as well as ranking within the state are indicated on Figures 2 and 3.

Mortality—Southern Indiana Counties

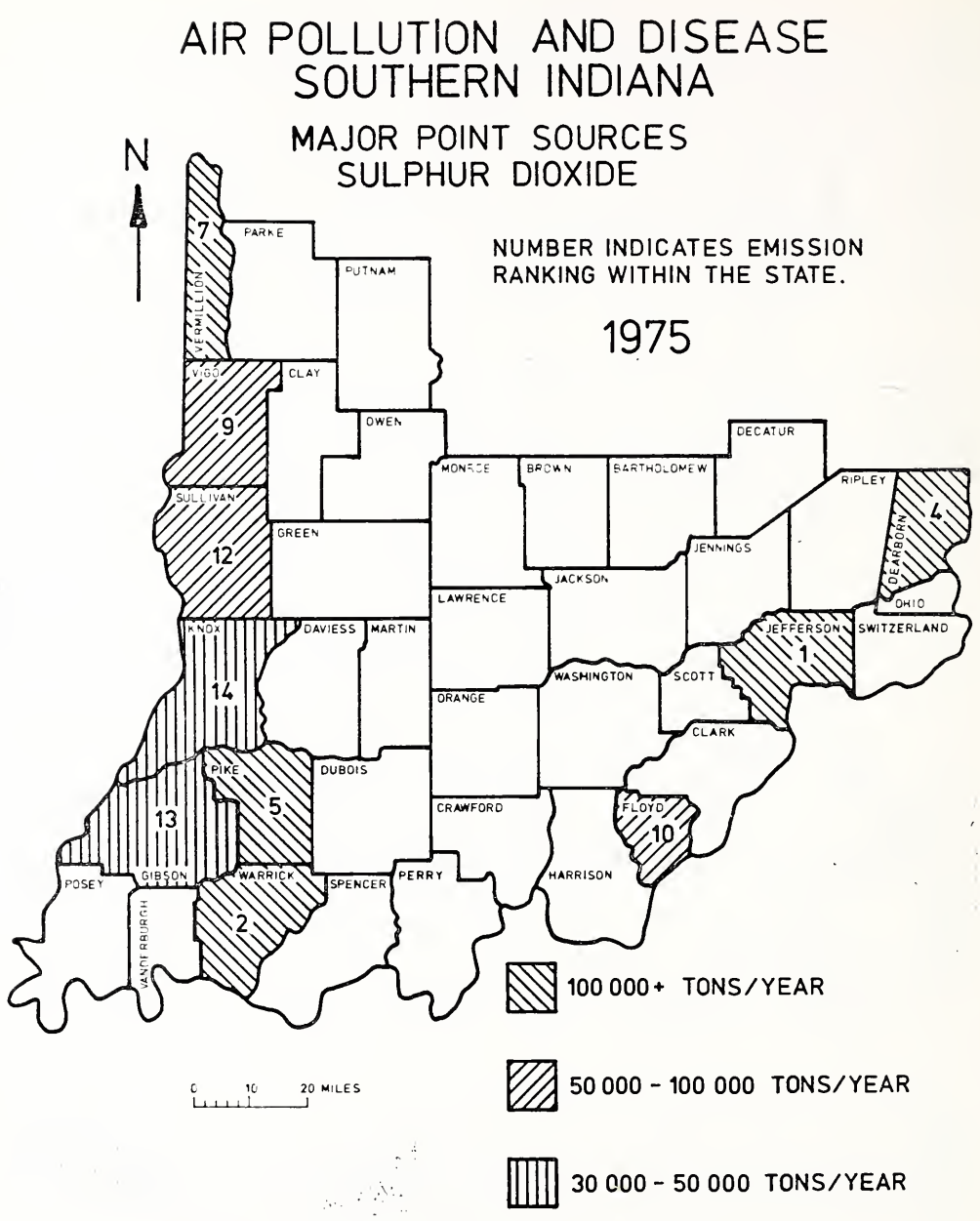
Data concerning mortality rates per 100,000 population for all air-pollution-related diseases was taken from Indiana Vital Statistics 1971-1975 and plotted by county on a map of southern Indiana. Diseases of the heart, arteries, stroke, respiratory system and cancer have all been linked by various studies with air pollution. Counties indicating high concentrations of three or more air-pollution-related diseases during at least four out of the five years studied from 1971-1975 are indicated on Figure 4. It is interesting to note that verifiable air monitors are not located in some counties with relatively high sulfur dioxide emissions while other low emission counties such as Bartholomew and Monroe have air monitors in operation. Many of the diseased counties are also rela-



tively rural and located downwind from high level industrial activity or coal-fired power plants. Prevailing winds within the area studied are from the southwest during summer and from the northwest during winter months. Results of this investigation concerning the geographic distribution of pollution-related diseases 1971-1975 revealed the following.

Heart Deaths. Southern Indiana counties indicating death rates considerably higher than the Indiana state average are: Clay, Parke,* Sullivan,* Vermillion,* Vigo, Greene,* Lawrence, Owen, Dearborn, Ohio, Ripley,* Switzerland,* Daviess,* Gibson,* Knox,* Martin, Pike,* Crawford,* Orange, Washington,* Posey, Spencer, Vandergurgh. Vermillion, Sullivan, Parke, Pike and Gibson counties indicate highest death rates due to heart disease. Heart death rates in some of these counties are 80-95% above Indiana state averages 1971-1975.

Stroke Deaths. Counties indicating particularly high rates of stroke deaths 1971-1975 are: Clay,* Parke,* Sullivan,* Vermillion,* Vigo,



Greene,* Lawrence, Owen,* Dearborn, Decatur, Daviess, Knox,* Pike,* Crawford, Harrison, Orange, Perry, Posey, Spencer, Vanderburgh.* Highest stroke death rates occur in Sullivan and Clay counties. Stroke deaths in some of these counties are 100-245% above Indiana state rates 1971-1975.

Arterial Deaths. Counties indicating unusually high death rates due to arterial disease are: Clay, Parke,* Sullivan, Vermillion,* Vigo, Dearborn, Jackson, Jefferson, Ohio, Daviess,* Gibson,* Knox,* Pike,* Perry, Posey,* Spencer* and Vanderburgh.* Highest death rates are indicated in Parke, Sullivan, Vermillion, Jefferson, Ohio, Gibson, Knox, Pike, Spencer and Vanderburgh. Some of these counties are 50-100% above the state rates for deaths due to arterial disease 1971-1975.

MAJOR POINT SOURCES SULFUR DIOXIDE

INDIANA

COUNTY	RANKING	EMISSIONS TONS/YEAR
°JEFFERSON+	1	267 798
°WARRICK	2	229 258
LAKE+	3	199 676
°DEARBORN	4	147 890
°PIKE	5	146 034
MARION+	6	130 664
°VERMILLION	7	108 738
PORTER	8	91 472
°VIGO+	9	89 573
°FLOYD+	10	85 869
LAPORTE+	11	70 697
°SULLIVAN	12	65 367
°GIBSON	13	39 494
°KNOX	14	31 451
°VANDERBURGH+		5 418
°MONROE+		5 019
°DUBOIS+		2 784
°BARTHOLOMEW+		209
°CLARK+		91
°PARKE+		0

°Located within Southern Indiana Health Systems Agency area.

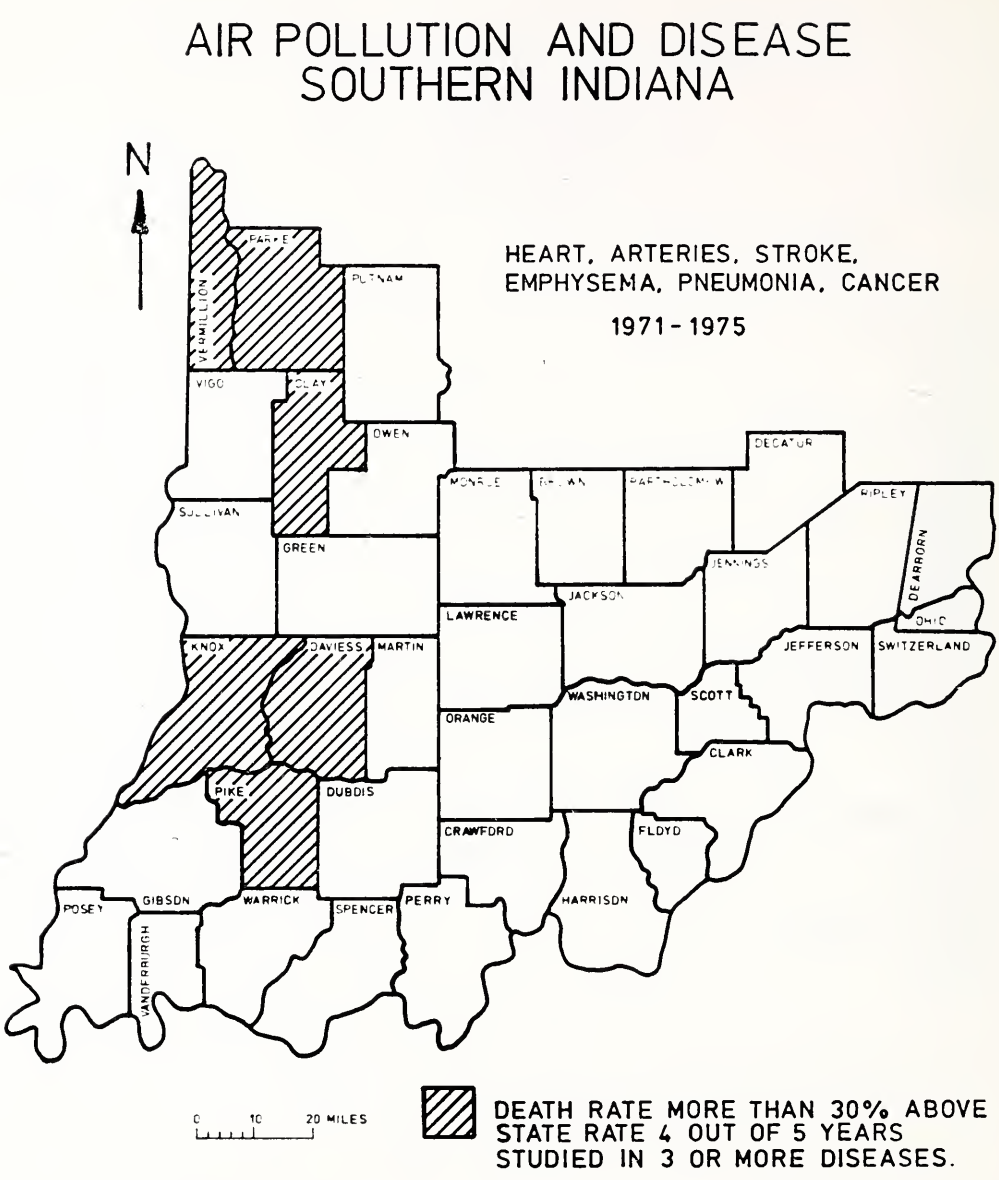
+State or U. S. EPA ambient air monitors present.

Source: U. S. EPA Emission Inventory 1975

Fig. 3

Emphysema Deaths. Counties indicating emphysema death rates considerably above the Indiana state rates are: Clay,* Vermillion,* Vigo,* Greene, Decatur, Ohio, Daviess,* Knox,* Pike, Floyd, Vanderburgh. Highest death rates from emphysema occurred in Clay, Vermillion, Ohio, Knox, Floyd and Vanderburgh Counties. Emphysema death rates in some of these counties are 60-200% above the state rate for the period 1971-1975.

Pneumonia Deaths. Counties indicating pneumonia death rates considerably above the stage averages are: Vermillion, Vigo,* Greene, Lawrence,* Decatur,* Jefferson,* Ohio, Switzerland,* Knox,* Crawford,* Orange,* Scott,* Perry, Spencer. Highest pneumonia death rates are found in Vermillion, Decatur, Switzerland, Orange, Perry and



Spencer counties. Pneumonia death rates in some of these counties are 75-100% above the Indiana state rates 1971-1975.

Cancer Deaths. Counties indicating cancer death rates (all types combined) considerably above the Indiana state rates are: Clay,* Parke, Sullivan, Vermillion,* Vigo, Greene, Owen, Brown, Jackson, Gibson, Knox, Pike, Crawford, Floyd, Orange, Vanderburgh. Highest cancer death rates are indicated in Clay, Vermillion, Gibson, Knox, Pike and Vanderburgh Counties. Cancer death rates in some of these counties are 30-50% above the Indiana state rates 1971-1975. A similar pattern of diseased counties is also indicated by unusually high concentrations of cancer of connective tissue as revealed in the Atlas of Cancer Mortality. (11) According to that study, Vanderburgh County has a larynx cancer

* Counties with asterisk have mortality rates more than 30% above Indiana State Rate, four out of five years studied.

mortality in the top 10 percentile of the country. Detailed information concerning cancer type, age, race, occupation, residence, and smoking habits were not available from the Indiana State Board of Health. Correlation of cancer type with particular pollutants is presently limited by lack of data.

Adjustments:

The authors realize that the air-pollution-correlated diseases (heart, arteries, stroke, emphysema, pneumonia and cancer), are also most often thought of as being the diseases of people over 45 years of age. It is for this reason that in Figure 4 we plotted only those counties that have death rates for these diseases that are 30% or higher than the Indiana state rate, for four out of five years studied in three or more diseases studied. The difference in the percent of the population over age 45 in the counties reported and the percent of the population over age 45 for the state is never more than 10. In this manner we believe that we have corrected for age where detailed mortality data was not available. Corrections for other variables such as occupation and smoking habits were limited by lack of data. However, death rates for air-pollution-related diseases are higher in southern Indiana than those found in northern Indiana.

Conclusions:

1. Numerous studies have concluded that air pollution causes or is linked with human disease.
2. Diseases most commonly associated with air pollution are those of the respiratory and circulatory system.
3. Air pollutants most commonly associated with human disease are sulfates, sulfur oxides, nitrogen oxides, ozone, hydrocarbons particulates and heavy metals.
4. Studies have shown that the acidity of the rainfall in southern Indiana has increased by more than ten-fold between 1956 and 1972.
5. Other studies have shown that in 1974 the sulfate concentrations in southern Indiana (western portion) ranged from 10-14 $\mu g/m^3$ and in the eastern portion of southern Indiana to be greater than 15 $\mu g/m.^3$ At levels of 6-10 $\mu g/^3$ (24-hour exposure) four studies have shown increased asthma attacks and at levels greater than 13 $\mu g/m^3$ (several years exposure) four studies have shown increased acute respiratory diseases in children. The major source of airborne sulfates is from coal-fired power generation. By 1990 computer studies have indicated that the sulfate levels in the Ohio River Valley should reach greater than 25 $\mu g/m^3$. At these levels (24-hour exposure) four studies show that increased mortality can be expected.
6. State air monitoring data in Indiana is widely scattered and covers 5-10 years of recent history. Prior to that time limited data is available. Many of the major air pollutants affecting human health are not consistently monitored at state monitors. Local air monitoring is frequently provided by industry, and is not verifiable by the state.

7. Morbidity data is not collected on a consistent basis throughout southern Indiana. Attenpts to correlate air pollution levels with hospital admission and discharge data were halted by lack of specific data necessary in both the air quality and the health fields.
8. Morbidity and mortality of children is thought to be the best monitor of air quality through clinic or hospital admission and discharge data. Most children are not exposed to extensive smoking or occupational health hazards, minimizing the statistical effects of these important variables in epidemiological studies.
9. Cancer statistics are thought to be the most accurately diagnosed and reported.
10. High rates of sulphur dioxide emissions are concentrated in several southern Indiana counties that are presently unmonitored by state or federal agencies.
11. Coal-fired power generation is the principal source of sulfur dioxide.
12. The uneven geographic distribution of death due to air-pollution-related diseases in southern Indiana counties indicates that these areas should be investigated in detail to determine whether air pollution is the cause of the excess deaths revealed by this study.

Recommendations:

1. Indiana health and air quality data should be made readily available to study groups. The limited amount of data, as well as the expense and difficulty in retrieving data, is stifling to detailed, long-range investigations.
2. State-operated air monitors should be located in the counties most affected by air-pollution-related diseases and in counties already indicating high levels of disease-related air pollutants.
3. Clinic and hospital admission data should be standardized, collected and correlated with air pollution levels in southern Indiana. This should be a continuing air-health monitoring program between health offices, physicians and hosiptals in southern Indiana. Data collected should include mortality and morbidity by zip code, occupation and smoking habits. This program should be designed to determine the impact of air pollution levels on morbidity and mortality.
4. Current air pollution regulations should be vigorously enforced so that the health of southern Indiana residents can be protected.

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