WILBUR A. STEGER
President
CONSAD Research Corporation
121 North Highland Avenue
Pittsburgh, PA 15206
(412) 363-5500

CLEAN AIR, SMALL AREA DATA AND THE URISA PROFESSIONAL

ABSTRACT: The United States, Canada and other nations are seeking to achieve and protect the global environment by improving the earth's air quality through reduction in acid rain, air toxics, pollution from mobile sources, elimination of ozone non-attainment ozone areas. Yet, it is at thousands upon thousands of local levels (neighborhood, cities, regions), where the consequences are realized — the protection of human health, the quality of life, and the local economic consequences. This paper, a continuation of others on the theme of how URISA members can utilize their expertise with small area data to assess and improve the environmental quality of their cities and metropolitan areas, will focus on the subnational analysis of the new U.S. Clean Air Act — how it achieves its objectives and what it may cost in both human and economic terms, at local and regional levels. URISA members must reach out and mesh their capabilities with specialists from both the environmental and public health communities to make the greatest impact.

INTRODUCTION

Last year at this time I reported on the revolution in access to sensitive environmental data bases. This new and rich body of information has evolved since Rachel Carson (the 60's), the U.S. Environmental Protection Agency (EPA, in the 70's), the unfolding health-affecting issues of the 80's (global warming, air toxics, indoor air pollution, asbestos in the schools, groundwater control, acid rain) (1) — and, now, in 1990, the elevation of EPA to a cabinet-level position, a pending Clean Air Act, the creation of a Bureau of Environmental Statistics (reporting to the President), and at least a dozen critical international global warming activities and institutions. (2) There is not only a year of further experience; there is also much more interest in local-level functions and responsibilities relative to the identification of environmental issues, prioritizations of needs and programs, and the effective execution of these programs.

In the case of URISA, there is increased excitement and activity about ways to relate what is happening at the local levels — both in policy and program as well as data and information terms — to both the national and now the international, global scene. The cross-boundary nature of most air quality environmental issues — e.g., acid rain, air toxics, ozone non-attainment, and others — is most appropriate for URISA interest, investigation, and activities in (combined) local-global policy, program and project interactions.

CLEAN AIR ACT AMENDMENTS FOR THE 1990'S

At the time of this writing (April, 1990), there is high expectation, and good probability, that there will be new Clean Air Act legislation. Regardless of its actual enactment, the component of this proposed legislation that has good promise for local-global interaction is the control of air toxic pollutants.

The Administration proposal for revising the Clean Air Act focuses on three main problems — acid rain, smog, and air toxics. Dr. Robert Hahn has summarized the three major components in this "nutshell": (3)

> "Acid rain has been a major concern to our Canadian neighbors and to the Northeast because of damages to lakes and forest resources that are thought to result from man-made emissions of sulfur oxides (SO_x) and nitrogen oxides (NO_x). Smog typically arises in urban areas that fail to impose adequate controls to meet the federal standards for conventional pollutants such as carbon monoxide, ozone, and particulate matter. "Air toxics" refers to a large class of pollutants, such as benzene and asbestos, that have been identified as toxic orcarcinogenic and that can be found in minute quantities in some airsheds."

With regard to the third — and newest, perhaps most penetrating and pervasive of the components — each of the leading air toxics legislative proposals for amending the Clean Air Act advocates a two-phased approach to regulating industrial emissions of toxic chemicals into the outdoor air. In the first phase emission control requirements focus on technology; in the second phase, they focus on public health effects. (4)

More specifically, in the first phase, industrial plants that emit hazardous air pollutants will be required by the various proposals to install either the maximum achievable control technology (MACT) or the best available control technology (BACT). The proposals differ, however, with regard to such issues as: the degree to which the Environmental Protection Agency will be allowed to consider cost, technical feasibility, and other non-health factors when determining the required effectiveness of control technologies; the applicability of the requirements to area sources (small stationary sources) and to mobile sources of emissions; and the compliance schedules stipulated for particular source categories. Each of these policy-level options holds different consequences for local-level decision-making and action.

In the second phase, regulated sources will be required to implement additional controls that are sufficient to reduce to reasonable levels the estimated residual risks to human health associated with population exposure to the emission levels achieved with the technology-based controls. Different proposals, however, specify different criteria for determining whether a particular source has achieved a reasonable level of risk. For example, specific House bills and Senate bills state that major sources of toxic emissions must ultimately reduce their residual risks to at most "one in 1,000,000 for the individual in the population who is most exposed to such emissions," although the Senate bill would allow sources that are unable to achieve the one in 1,000,000 level to continue operating if their residual risks can be limited to one in 10,000. In contrast, the administration proposal grants the EPA substantial discretion in assessing the reasonableness of the public health risks that remain after sources have installed particular technological controls.

At the local level, regardless of which policy option is ultimately selected, it will be necessary for local level public health officials to examine and weigh the available scientific evidence about the health effects of specific hazardous air pollutants. What follows, is a "case study" — concerning Allegheny County, Pennsylvania, a leader in air quality improvements for many decades — which I believe presents an excellent illustration of ways for URISA professionals to become involved at the local level, by interacting with State and national level policies and global level clean air issues and worldwide environmental health data bases and expertise. The Allegheny County issue, repeated in dozens of other localities in the U.S. and industrial communities worldwide, relates to the development, assessment, and policy uses of the scientific data on the health outcomes associated with human exposure — both occupational and environmental — to steelmaking coke oven emissions.

HEALTH EFFECTS ASSOCIATED WITH ENVIRONMENTAL EXPOSURES

Allegheny County, with one of the highest concentrations of coke plants in the country, is a prime location for illustrating ways to investigate the health effects of environmental exposure to toxic chemical emissions. This, and similar small-area data collection, data base design and development, and local and regional analysis, will need to be repeated thousand-fold in the 1990's and into the twenty-first century.

Direct evidence of the effect on public health associated with exposure to outdoor levels of coke oven emissions is provided by data compiled by the National Cancer Institute in the Third National

Cancer Survey. On the basis of these data, we calculated age-adjusted cancer incidence rates for males and for females in thirty geographic areas within Allegheny County for the three-year period from 1969 through 1971. (5) We computed separate incidence rates for numerous forms of cancer, including, most importantly, the forms of cancer shown to be associated with occupational exposure to comparatively high levels of coke oven emissions.

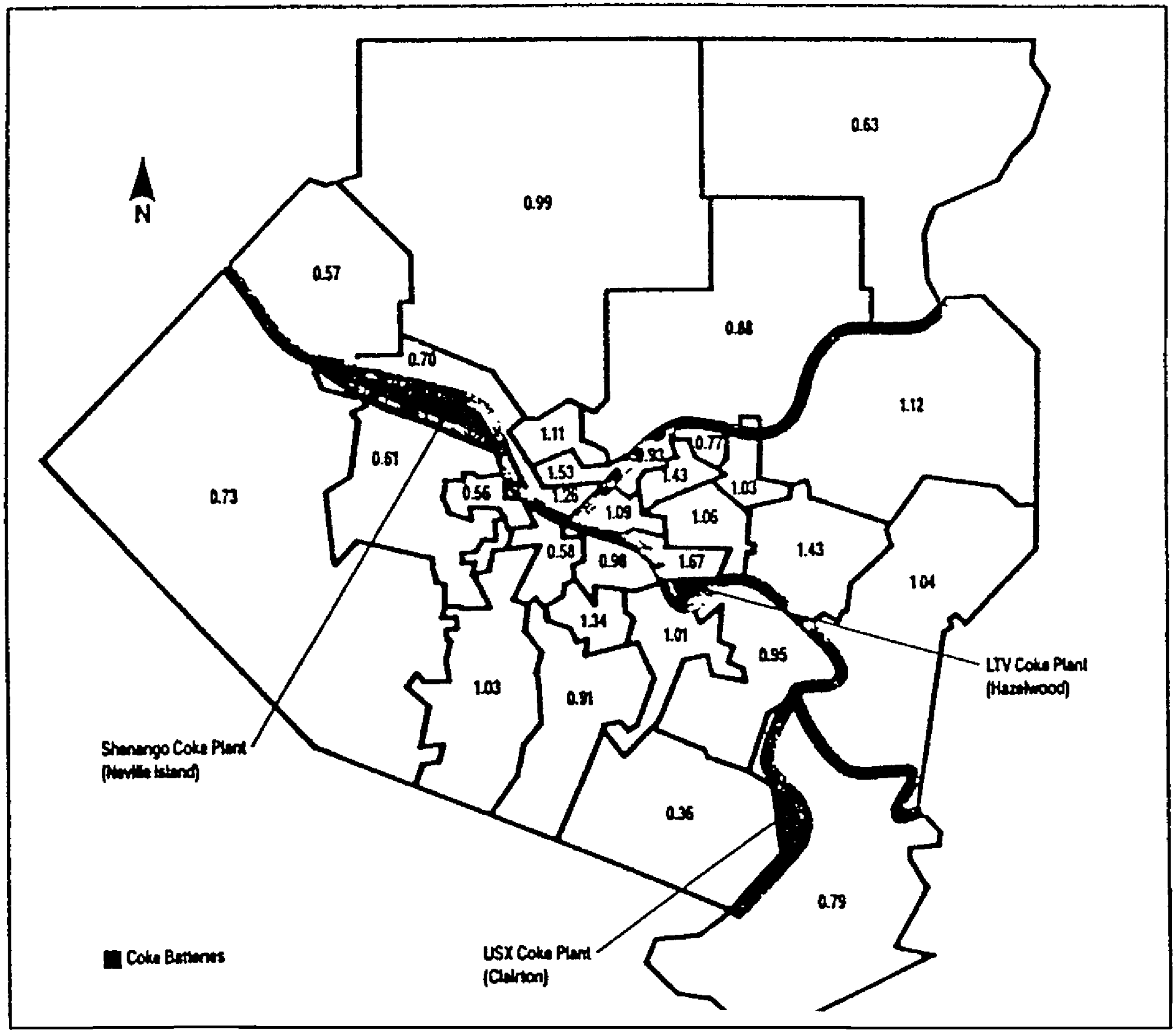
For each form of cancer, there is substantial variation in incidence rates for both males and females among the thirty geographic areas within Allegheny County. But when we examine the spatial patterns displayed by the incidence rates (i.e., realized cancer) across these areas, we find no coherent pattern of higher cancer incidence rates in areas adjacent to coke plants in comparison with the incidence rates in areas farther away from the coke plants. Indeed, by simply looking at the spatial patterns of cancer incidence rates and assuming that coke oven emissions contribute to excess cancer risks, it would be impossible to infer the locations of the three coke plants in Allegheny County.

This circumstance is illustrated in Figure 1 with reference to the average annual age-adjusted incidence rates calculated for cancers of the respiratory system among females (6) residing in Allegheny County between 1969 and 1971. The figure contains a map of the thirty geographic areas in the county and specifies for each area the ratio of the incidence rate for that area to the incidence rate for the entire county. Ratios greater than 1.0 indicate areas with excess risk of respiratory system cancers relative to the whole county, and ratios less than 1.0 indicate areas with below-average risk. The locations of the three coke plants in the county are depicted in the figure as shaded sites.

The most notable result displayed in Figure 1 consists of the ratios shown for the areas adjacent to the USX Corporation coke plant at Clairton, located in the southeast portion of the county. The Clairton coke plant is the largest coke-making facility in the nation, yet the ratios calculated for the areas adjacent to the plant are substantially below the county average. In fact, the ratio for the area in which the plant is located is the smallest one computed for any of the thirty geographic areas. This result is especially important because cancers of the respiratory system are the forms of cancer that have been most consistently associated with high levels of occupational exposure to coke oven emissions, and because females most likely provide the purest indication of the health impact of environmental exposures to coke oven emissions because of the small probability that females have been occupationally exposed to such emissions.

We observe similar results for the areas adjacent to the Shenango coke plant located on Neville Island in the western portion of the county. The ratios calculated for those areas are uniformly less than the county average. In addition, the ratios tend to increase with distance from the plant, whereas one would expect risk gradients in the opposite direction if outdoor concentrations of

Figure 1: Average Annual Age-Adjusted Incidence Rates for Females, 1969-1971, for Cancers of the Respiratory System: Ratio of Rates for Thirty Areas within Allegheny County to Overall County Rate



coke oven emissions were an important factor contributing to the risk of respiratory system cancer.

In contrast, in the areas adjacent to the LTV Steel Company coke plant in Hazelwood, located near the center of the county, the ratio for the area in which the plant is situated is the largest one computed for any of the thirty areas in the county. In addition, proceeding toward the Northeast (the normal direction of the prevailing wind), the ratios steadily decline. Conversely, for males, we have found that the ratios for areas downwind from the coke plant are roughly at or below the county average; whereas, for areas upwind from the plant, the ratios are considerably higher than average. It would be biologically implausible to conclude that environmental exposures to coke oven emissions contribute materially to these diametrically opposite health outcomes observed for males and for females.

Moreover, we have derived comparably incoherent results for all other forms of cancer examined. The observed risk patterns are often contrary to expectations. Cancer incidence rates for the same geographic area are frequently inconsistent for males and for females in that they indicate above-average risks for one sex and below-average risks for the opposite sex. Also, cancer incidence rates in the areas adjacent to the three coke plants are generally inconsistent with the relative levels of emissions from the plants.

Together, the foregoing evidence strongly indicates that factors other than exposures to outdoor concentrations of coke oven emissions are the predominant sources of the observed variations in cancer incidence rates throughout the county. Such factors include occupational exposures to toxic chemicals, smoking and dietary behavior, and socioeconomic characteristics.

IMPLICATIONS FOR THE URISA PROFESSIONAL

Clearly, URISA professionals wishing to enter this "scientific-public policy" field face unlimited opportunity and challenge, in confronting "accepted dogma" about environmental health effects with increasingly probing investigations of underlying "scientific" causes. The field of inquiry, formerly open only to professional toxicologists and epidemiologists, now calls for superb teamwork between information technologists, analysts, and local level public health professionals and industry occupational and environmental health experts and management. The URISA professional can — and should — use his/her skills and expertise, to investigate and assess the available scientific evidence considered at appropriate levels of aggregation and placed in proper perspective.

To the degree that cancer risks incurred by small groups of people are regarded as valid bases for public health policy, URISA professionals should use their expertise and "political" skills to ensure that the evaluation of those public health risks should <u>not</u> be derived from abstract and unrealistic models containing totally unrealistic assumptions about people's activity patterns and associated exposures to health risks. Instead, these should be accomplished through direct measurements of exposures to hazardous air pollutants actually experienced by individuals in those groups and of the empirical importance of outdoor and indoor concentrations as origins of those personal exposures. "Hard-nosed," probing, and skilled use of available — and accessible —data bases will prevent thousands of localities from making uninformed, public hysteria-driven decisions, with little or no basis in science and public policy, and involving enormous damage to the community's economic structure. Clearly, exposure measurements must be taken giving due and adequate consideration to the formal procedures for incorporating wind and disposition patterns, indoor-outdoor differences, quality assurance, sampling, exposure sources, activity patterns, and other dimensions of the technical approach. (7)

Examination of the economic and social consequences of these decisions — e.g., the jobs impact of alternative plant closings and expansion local-level permitting decisions — is another major small area data assembly and analysis task. Figures 2 to 6 portray the geographical spread, for example, of the Clean Air Amendment options, at the county level for the Northeastern United States. Prospective jobs impacts are displayed — in the original, on dozens of multicolor maps — by county and industrial sector. (8) Utilized in the debate at the national level, (9) analysis of the balance between improved public health and local level employment and income requires the most penetrating and responsible skills the URISA professional can bring to this local/state/national/global level set of problems and opportunities.

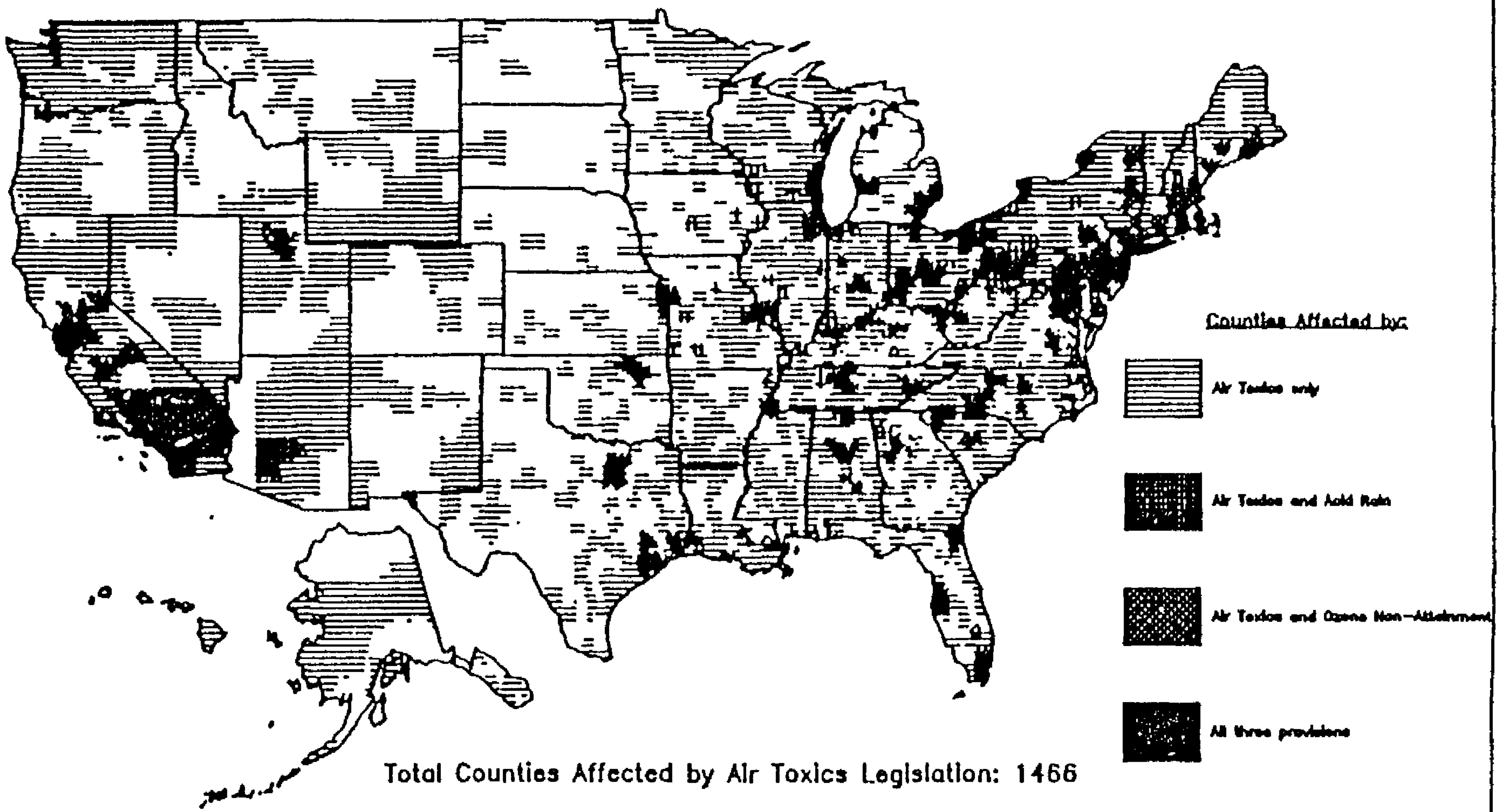
Next year, at this time — air quality and global warming willing — I will attempt to complete a trilogy of papers on the subject of local/national/global issues of great relevance to the inquiring, searching, and responsible URISA professional.

Figure 2: **Clean Air Act Amendment Impacts**

Air Toxics: Full Compliance with 98% MACT

and One in One Million Residual Risk Requirement

Counties Affected by Air Toxics, and by Acid Rain and/or Ozone Non-Attainment



Total Counties Affected by Air Toxics Legislation: 1466

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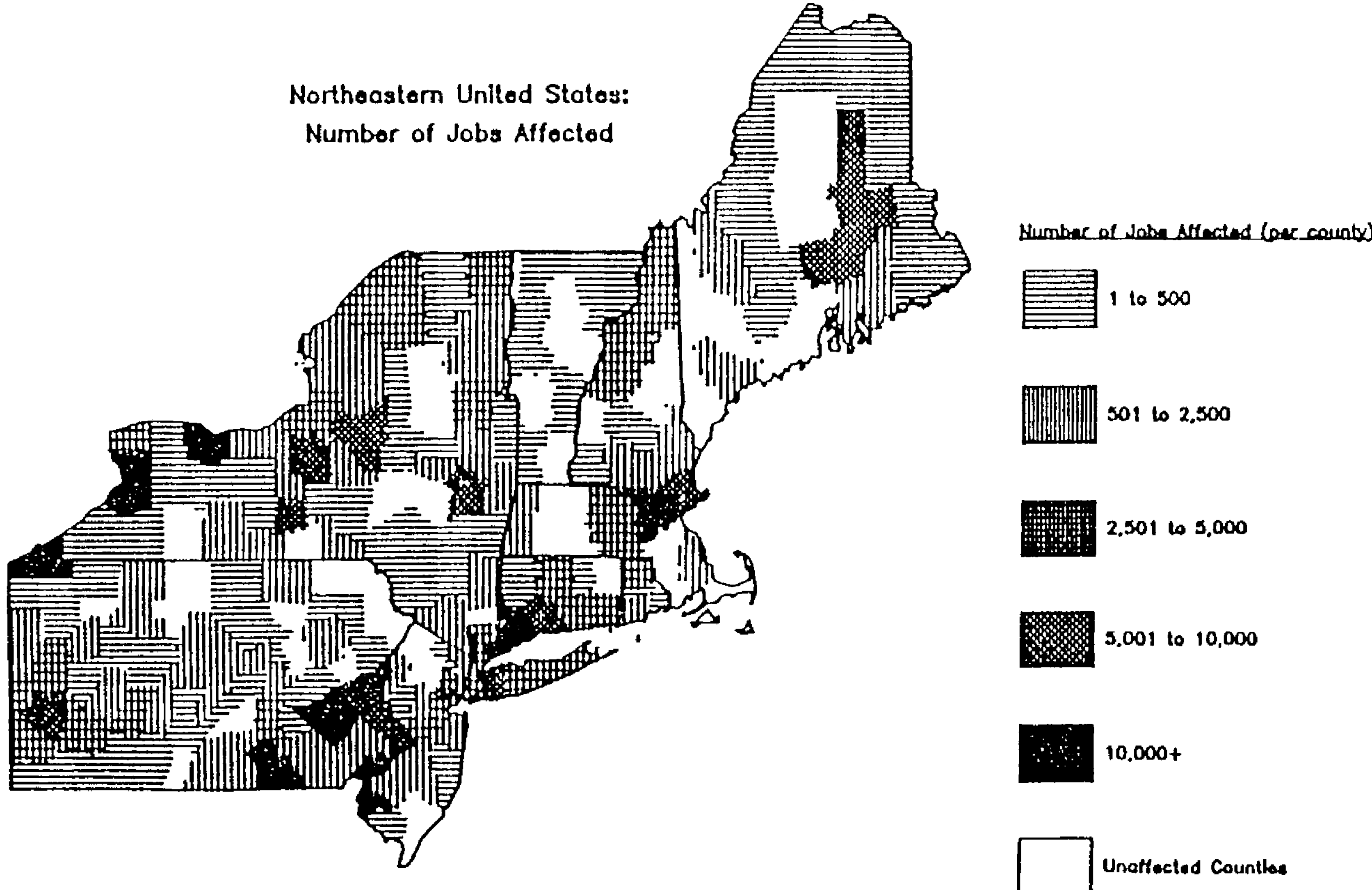
Figure 3: Clean Air Act Amendment Impacts

Air Toxics: Full Compliance with 98% MACT
and One In One Million Residual Risk Requirement



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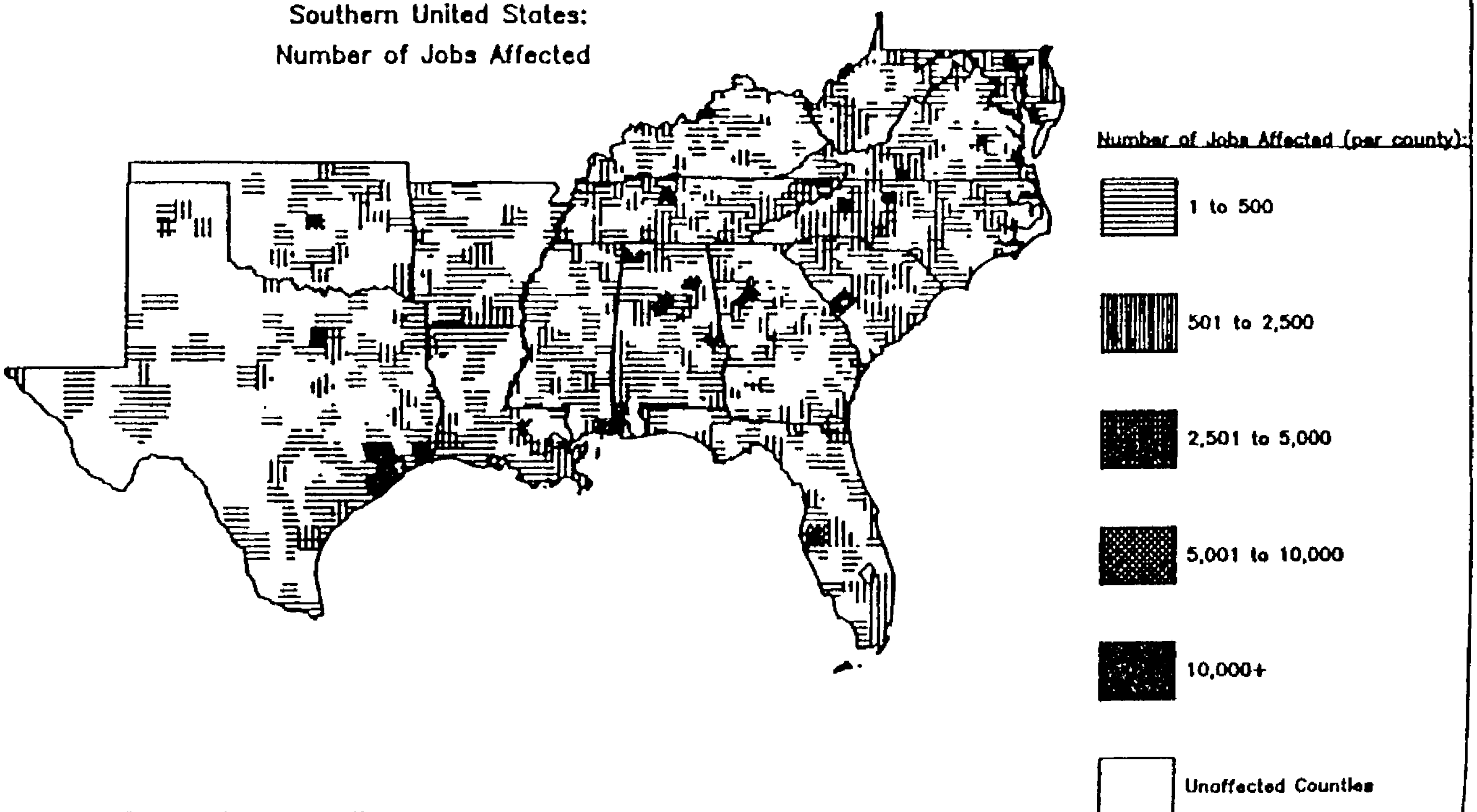
Total Number of Jobs Affected (Nationwide) by Air Toxics Legislation: 2,417,000

Figure 4: Clean Air Act Amendment Impacts

Air Toxics: Full Compliance with 98% MACT
and One in One Million Residual Risk Requirement

Southern United States:
Number of Jobs Affected



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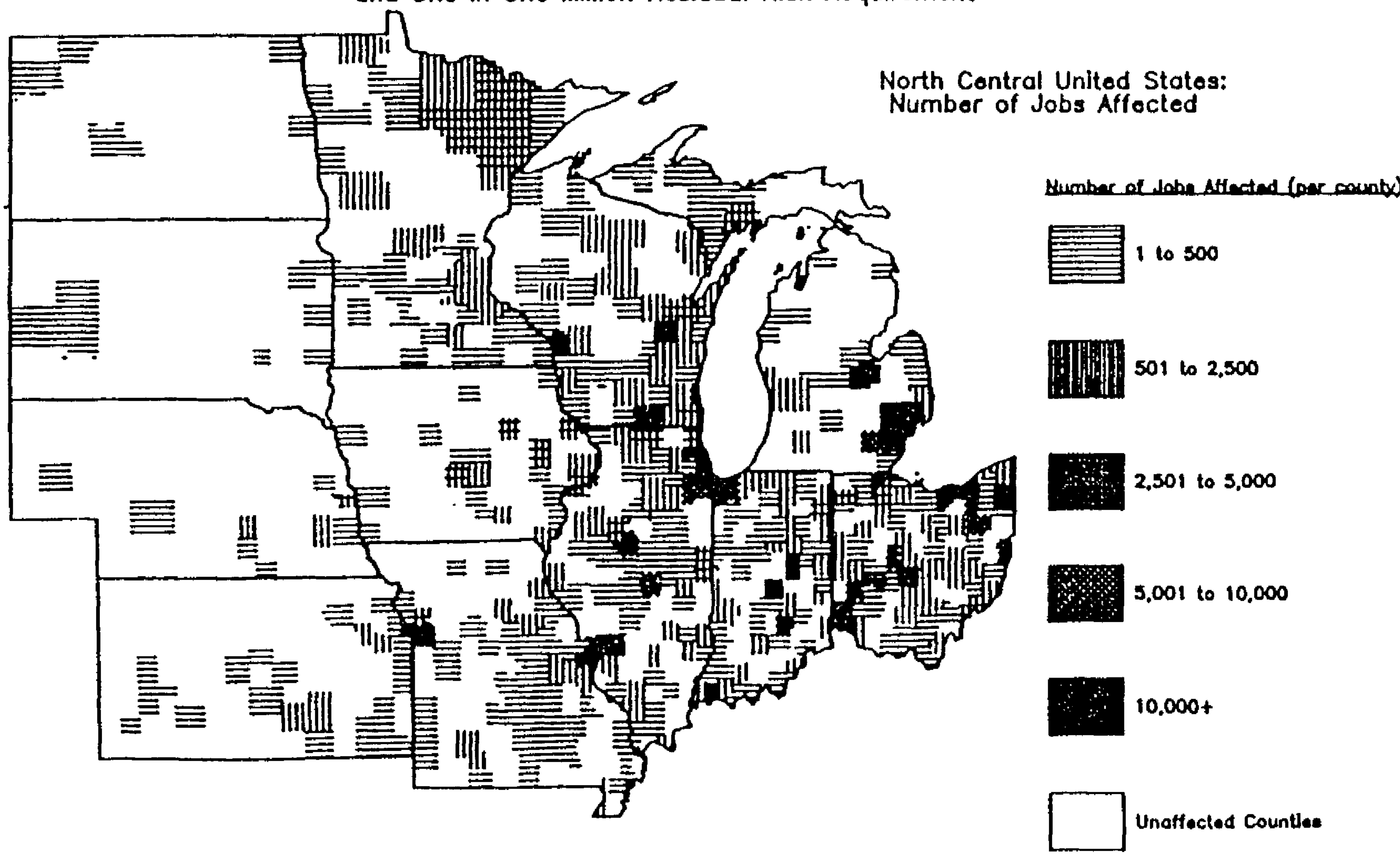
Total Number of Jobs Affected (Nationwide) by Air Toxics Legislation: 2,417,000

Figure 5: **Clean Air Act Amendment Impacts**

Air Toxics: Full Compliance with 98% MACT
and One in One Million Residual Risk Requirement



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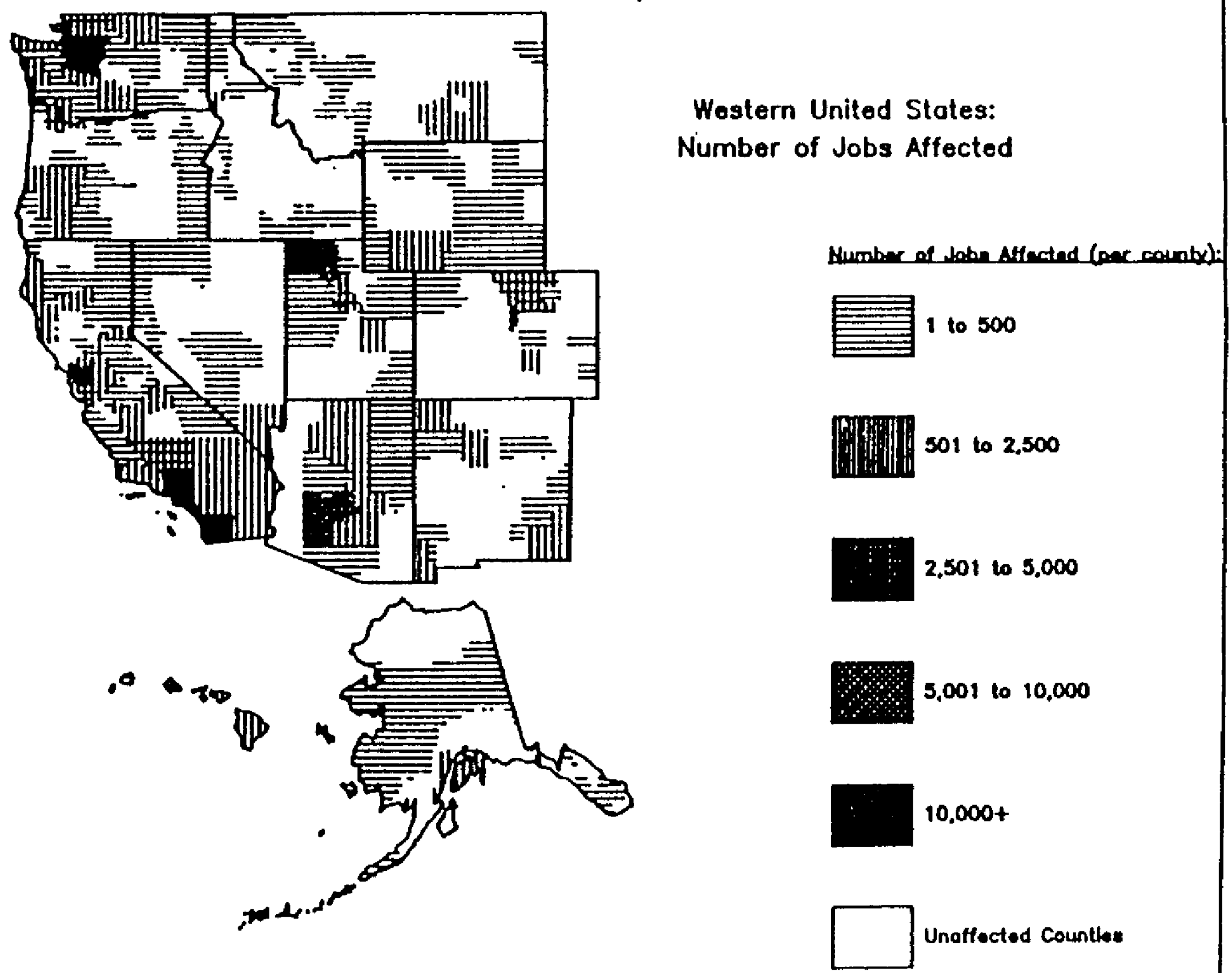
Total Number of Jobs Affected (Nationwide) by Air Toxics Legislation: 2,417,000

Figure 6: **Clean Air Act Amendment Impacts**

Air Toxics: Full Compliance with 98% MACT
and One in One Million Residual Risk Requirement



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Total Number of Jobs Affected (Nationwide) by Air Toxics Legislation: 2,417,000

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(6) Females are used to avoid the double-counting of male steel-mill workers also residing in the same community.

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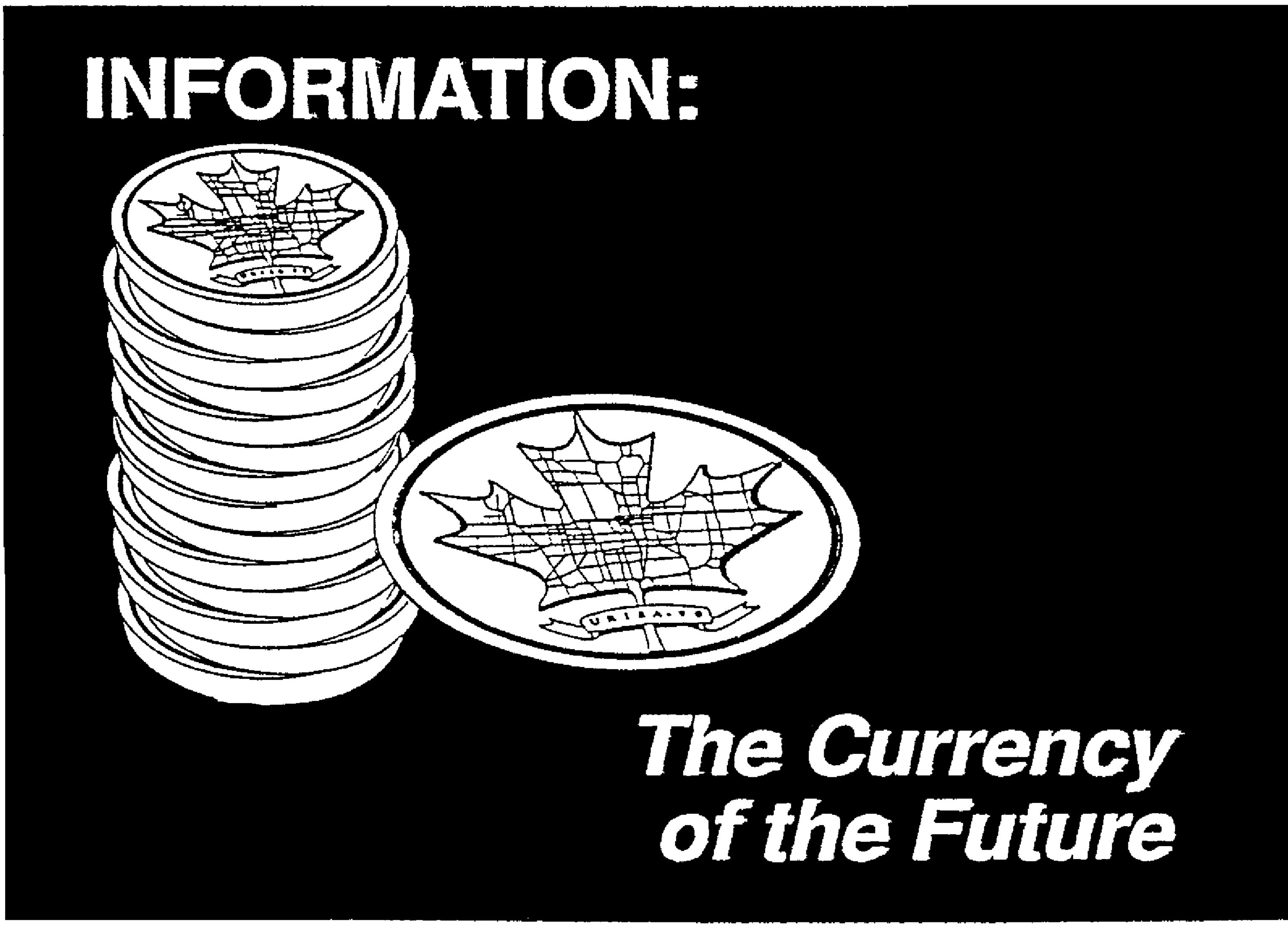
Proceedings of the 1990
Annual Conference of the

Urban and Regional Information Systems Association

Edmonton, Alberta



VOLUME II

GEOGRAPHIC INFORMATION SYSTEMS

URISA '90 graphic courtesy of ESRI, the 1990 Graphic Design Competition Winner

EXCERPT: PUBLIC SAFETY RELATED PAPERS

U R I S A   P R O C E E D I N G S

Papers from the annual conference

of the

URBAN AND REGIONAL INFORMATION SYSTEMS ASSOCIATION

August 12 - August 16, 1990

Edmonton, Alberta

Volume II:

Geographic Information Systems

Edited by:

William Bamberger

Regional Urban Information System
San Diego, California

INTRODUCTION

by Gene Trobia and William J. Bamberger

Geographic Information System (GIS) technology has matured and become a usable reality. In the past, many papers presented in the GIS volume of the URISA Proceedings have concentrated on documenting GIS uses and capabilities. Now that GIS has proven effective and feasible, the major concern has shifted to how to invest in a GIS and make it pay off for an organization.

With the above in mind, it is understandable that this years's papers are concerned more with implementation, planning, standards, management, applications, experiences, and innovation of GIS than explaining its capabilities.

Implementation and management issues are the focus of the first section. Implementation of a GIS requires organizational changes. How to restructure the organization and to insure a successful implementation are the subjects of several papers. Another issue addressed is assuring that GIS is used effectively to meet the many diverse requirements within the organization. One paper discusses appropriate strategies for system management. As technology trends lead toward more powerful, decentralized workstations, the need for effective management of the GIS environment becomes extremely important. What was administered in the past on one central computer must now potentially be managed effectively for desktop processing and applications.

The second section addresses the need for data and system standards as well as quality assurances. Standards and quality are equally important to a developing and thriving GIS.

The third section presents case studies of GIS experiences at various installations. These papers demonstrate real world needs that were dealt with successfully. The emphasis of the presentations range from development of entire integrated systems, to development of specific applications. All papers in this section are based on experience gained by being "in the trenches".

Street network applications are dealt with in the fourth section. Topics include using federally produced TIGER files, development of a cooperative implementation approach, and provincial applications. Each paper deals with a major area of concern in GIS regarding street network processing.

Lastly, the fifth section demonstrates creative applications of GIS. Several innovative uses of GIS are presented, including a very pragmatic, verifiable, and highly creative GIS application to perform municipal fiscal analysis. Another discusses using GIS to assess the quality of urban life. The use of object-oriented data base approaches to perform spatial analysis is also presented. The final paper discusses innovative ways of developing GIS data.

EXCERPT FROM TABLE OF CONTENTS, VOLUME II
* = Public Safety Related Papers

CASE STUDIES

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