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CASE STUDIES AND A DIALOGUE ON THE ROLE OF GEOGRAPHIC ANALYSIS IN PUBLIC POLICY

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Marilyn A. Brown, Editor

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- Lawrence A. Brown
- Michael R. Greenberg
- Peter Haggett
- John D. Nystuen
- Maurice H. Yeates

PAPER NUMBER 12

June, 1979

Editor of Occasional Papers: Rick Mattson

GEOGRAPHY GRADUATE STUDENT ASSOCIATION
 UNIVERSITY OF ILLINOIS at Urbana-Champaign

Case Studies and a Dialogue on the Role of
Geographic Analysis in Public Policy

Edited by

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INTRODUCTION

Marilyn A. Brown

Many geographers are developing a sense of responsibility about pursuing research which can contribute to the solution of society's maladies. They are also feeling more and more compelled to apply their research to the development of public plans and programs by establishing ties with those institutions in society that make decisions affecting the public good.

Yet much of the geographer's store of information is still neglected by the public (and private) sector. In the United States, in particular, geographic analysis has had little impact upon public policy.

This ineffectiveness has resulted, in part, from the reluctance of some academics to become explicitly involved in "social engineering." Trewartha (1973), for instance, fears that university classes could become "indoctrination sessions," where geographers promote their personal views concerning the social order. Radical geographers, however, argue that values are an inextricable part of academic research and that the role of impartial analyst is both impossible and inexcusable.

The issues surrounding the involvement of geographers in public policy formulation, implementation, and monitoring are complex and numerous. In order to stimulate debate on these issues, the Department of Geography at the University of Illinois, Urbana-Champaign hosted a Symposium on "The Role of Geographic Analysis in Public Policy."¹

¹The Symposium was organized by Arthur Getis, Geoffrey Hewings, and myself, all of the University of Illinois' Department of Geography. Getis chaired the sessions.

Five distinguished geographers were invited to the University to participate in the Symposium. Of these, Lawrence Brown, Michael Greenberg, John Nystuen, and Maurice Yeates were asked to describe public policy issues related to their research on diffusion of innovation, geography of cancer, management of water quality, and urban growth, respectively. Peter Haggett was asked to synthesize and comment upon their remarks. In addition, faculty and graduate students at the University of Illinois were invited to contribute to the discussion that followed each talk. This paper presents a transcribed and edited version of the tape-recorded proceedings of the Symposium.

Despite the diversity of research topics discussed by the invited guests, overlapping themes emerged. For instance, several of the speakers stressed the need for geographers to become involved in questions of the distribution of society's public and private "goods" and "bads." In this vein, Brown noted the importance of studying the impact of actions by agencies in both the private and public sectors upon the diffusion of innovation and resulting welfare inequalities. Yeates discussed the impact of actions of the Canadian government, including the location of federal jobs, on the differential growth rates of Canada's provinces and territories.

The speakers also illustrated some of the problems unique to public policy research. For instance, when geographers deal with issues that are of great public interest, but which must be pursued in partial secrecy due to the confidentiality of data (or other reasons), findings may be difficult to publish, they may leak prematurely, or they may be distorted dramatically.

Geographers dealing with public issues must also be aware of the ways that problems may be camouflaged through political machinations. For instance, "needs" can be redefined to meet budget constraints, or air quality can be "improved" by changing the location of air quality monitoring stations.

Several of the talks, including Haggett's discussion of a typology of research, stressed the difference between public policy research dealing with well-defined versus poorly-defined problems. Geographers appear to do quite well when problems are sharply focused, as in the development of location-allocation solutions. They are less successful, however, when tackling broader issues such as the "poverty problem."

Perhaps the most important concensus emerging from the Symposium is that geographers must seek greater influence with policy makers and the public in general. They should at least become more verbal. As Greenberg noted, "since most public policy decisions are made for political reasons with little regard for what an academic has to say, you might as well say what you think." A tradition of such involvement already exists in Canada, where Yeates notes that geographers have for a long time spoken out. Such a tradition needs to be established in the United States, as well.

Literature Cited

Trewartha, G. T. 1973. "Comments on Gilbert White's Article 'Geography and Public Policy'," Professional Geographer, 25: 78-79.

Cancer Research in New Jersey

Michael R. Greenberg

When you live in a state like New Jersey, wedged between the New York and Philadelphia metropolitan regions, it is difficult to do any applied research without its having public policy implications. The geography of cancer mortality in New Jersey, the problem I am concerned with, for instance, is of great interest to the public. Cancer is one of the most feared diseases. The public and especially reporters are extremely interested in our work. As a result, we have had a difficult time avoiding premature publicity.

I will briefly discuss three studies that we are involved in and then will relate these studies to four public policy questions. In the first study, we examine the relationship between cancer mortality and factors which are assumed to be related to elevated and reduced risks of cancer. Our cancer mortality data are from the National Cancer Institute and the University of Missouri and presently are predominantly at the county scale. Using these data, we prepared a series of maps of cancer risk pertaining to the various body sites. One of our first findings was a nonrandom pattern of high cancer mortality risk among white males extending through Connecticut, New York City, the New York City suburbs, through New Jersey, and into Philadelphia (see Figure 1). Anyone familiar with this area will realize that this is the urban industrial corridor. That finding in itself, when presented to the state, generated a lot of interest.

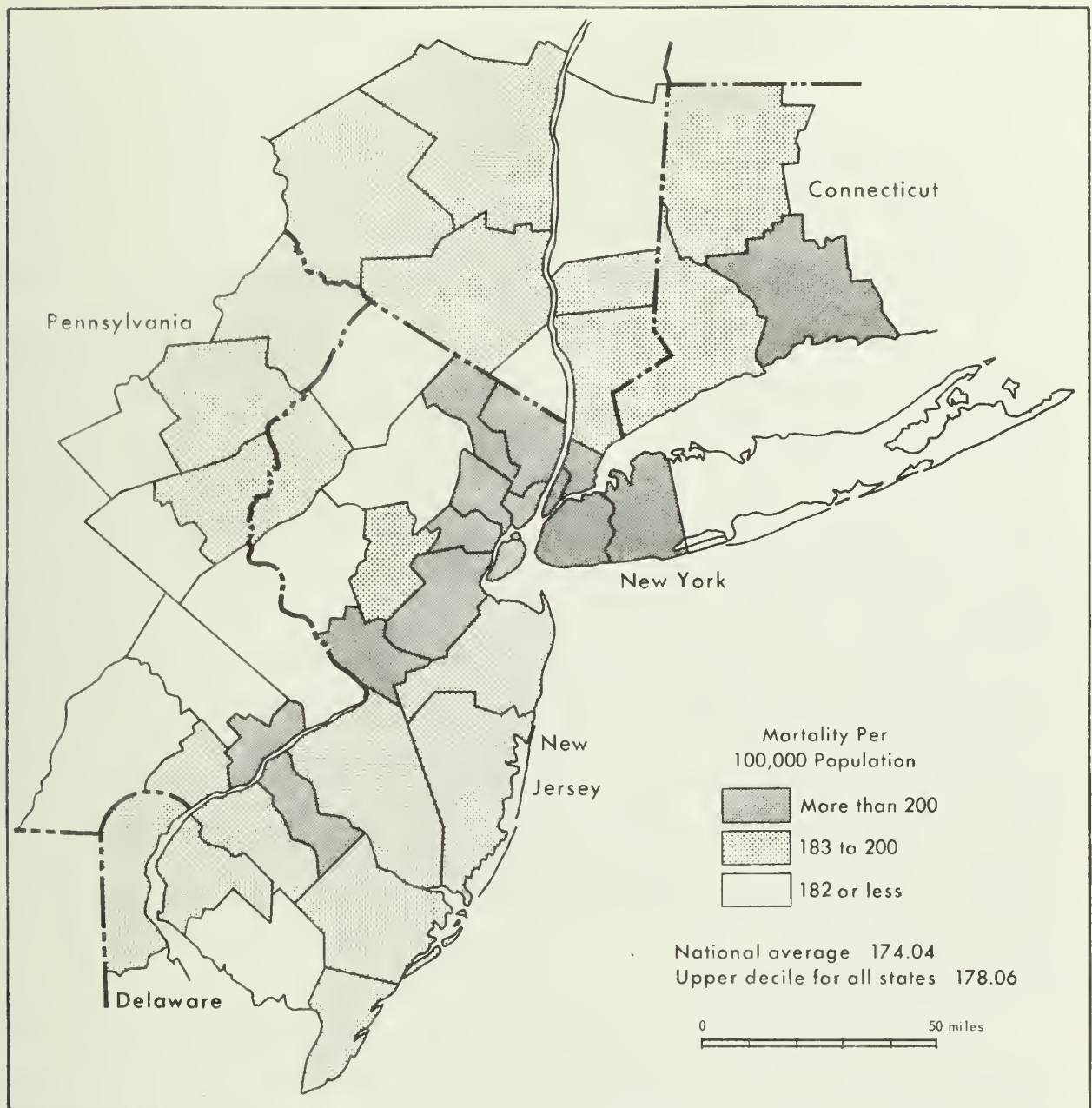


Figure 1: Male White Cancer Mortality in New Jersey and Surrounding Counties, 1950-69

After mapping the data, we tried to determine, by consulting the literature, what factors increase the risk and what factors reduce the risk of contracting cancer. The factors we examined can be divided into three categories: (1) Local Ambient Environmental Factors, (2) Occupational Environmental Factors, and (3) Personal Environmental Factors.

It is very popular today to try and blame cancer on Local Ambient Environmental Factors, such as contaminated air and dirty water. Some people prefer to blame cancer on some external agent over which they theoretically have no personal control. If the local ambient environment is to blame, anger can be vented at industry and government. The risks of the Occupational Environment are well known in the cancer literature. Depending on whose document you read, from 12% to 25% of male cancer mortalities are caused by occupational exposures. The third general group of factors, the Personal Environmental Factors, include smoking, excess alcohol consumption, nutrition, certain types of drug consumption, excess exposure to sunlight, and numerous other factors.

Maps and statistical methods were used to compare the county-level geographical pattern of cancer mortalities with the elevated and reduced risk factors. Whereas I did not expect many significant associations, we found quite a few. This caused us to wonder whether we have an ecological fallacy of abstracting from county scale data down to individuals, or whether the relationships actually mirror the real world. For example, there were some strong relationships between certain cancers and certain ethnic groups, with the latter probably acting as surrogates for dietary habits, smoking, alcohol consumption, and a variety of other factors.

Overall, this first study is an extremely complicated project, with thousands of correlations. The first report we prepared for the state was approximately 450 pages, and it is currently being reviewed. Hopefully, it will be released in early 1979. My biggest fear is that the associations we found will be taken out of context, and that our work will be misused because people refuse to heed the caveats.

The second study examines how much exposure people may be getting to carcinogenic substances in the air and water. It is based upon data that the state of New Jersey has spent over \$200,000 to collect.

Here is an illustration of what we have been doing. Generally, carcinogenic substances in ground water fall into three groups: metals, pesticides, and other organics. Using standard statistical methods including correlation, factor, canonical, and cluster analysis as well as mapping techniques, we looked for chemical associations in ground water. Then we tried to relate these chemical groups to other variables such as the age of well, depth of well, the particular aquifer, and land use and other features around each well site. The preliminary work shows numerous relationships which we are still examining. We are particularly interested in those water supplies which are public potable in nature, which include many of the samples we have.

The third study, and to me the most interesting, examines industry produced carcinogenic substances. New Jersey has received a grant from the federal Environmental Protection Agency to do the first survey of this kind. Industries are to indicate what carcinogens they produce, where residuals

are disposed of (air, water, and solid waste), and other data.

Some of the data are confidential; no one may see these data except myself, my programmer, and the state officials. The data are put into the computer in a scrambled format so that if it were thrown out on the table in front of you, you wouldn't know what the numbers meant. We use key words memorized which enable us to unscramble the data. As the questionnaires come in from industries, they are entered into the computer and then shredded. This study is basically just beginning, we've got a few sample questionnaires and are now just setting up a data base.

Now let me relate these three studies to four public policy questions:

- (1) Should the problem be studied?
- (2) Where and how should it be studied?
- (3) What do the results mean?
- (4) How should the results be used?

People are prone to jump directly to the fourth question: How should the results be used? My experience suggests that we start here: Should it be studied? That in itself is a rather significant policy decision. In the case of our study, New Jersey has about a \$2,000,000 budget to do cancer and hazardous substance research. No other state, to the best of my knowledge, has put that amount of money into such research. It's crucial that geographers, social scientists, environmental scientists, and others put pressure on additional states that might have similar problems to do such studies.

The second policy question is also important: Where and how should the problem be studied? I, for example, can select areas where contaminants

probably won't be found in the water supply. I can also choose areas where contaminants are frightfully abundant. In debates on where to do these studies, there are many individuals who will prefer to conduct a study in one area because they think it will support their preconceived findings. Geographers and other scientists should make public any information they have which is relevant to the where and how questions. The people who make the decisions are frequently not well informed about what to do and where to do it. So give your best reasoned judgments; they may be crucial.

What do the results mean? Different people can look at the same results and see different things. Geographers and epidemiologists have read the first study report and come out with very different conclusions. It's a serious mistake to allow only doctors and epidemiologists to read this type of research. Whereas epidemiology is a very old, well developed science, we routinely use certain techniques that they do not often employ, or do not employ as effectively as we do. Of course, the converse is also true; we can learn a good deal from other scientists. And so I think that both in use of methods and interpretation of results, we should play a role.

Finally, How should the results be used? This probably is the most controversial of the public policy questions. I personally make my opinions known, orally, if not in writing on all of these issue questions. Since most public policy decisions are made for political reasons with limited regard to what an academic has to say, you might as well say what you think.

Of the four public policy questions I have defined here, geographers

and other social and environmental scientists should definitely have strong input on questions 1, 2, and 3, and should make their opinions known about question 4, while not expecting anyone to adhere to them.

L. Brown: How did you get in the position to head up these studies?

Greenberg: I was able to demonstrate that we could analyze their data. Luck is also involved. If I were interested in cancer and lived in a state which wasn't totally alarmed about cancer rates, I probably would not have been so fortunate.

L. Brown: But how did you get the opportunity to demonstrate your skills?

Greenberg: The state published a report containing maps which I redid, which were more informative than their original maps. In addition, I have, over the years, built a rapport with the Department of Environmental Protection, having done various other studies on hazardous wastes, solid waste, coastal zone management, and water pollution.

Nystuen: What are the three most important public policy recommendations that you would make?

Greenberg: First, the geography of diseases in addition to cancer needs to be studied at as many geographical scales as the data are available. Epidemiologists are prone to focus predominately on small-scale data, actual case examinations. They, therefore, may miss many important factors. More geographic case studies like this one are needed, and public funds for these should be made available. Second, we hope to be able

to distinguish between background and severely polluted areas. If we are successful, I would like to see ambient environmental standards promulgated reflecting these standards. Third, we hope ultimately to be able to suggest which plants and which industries in New Jersey should have stricter controls on their water, air, and solid waste emissions. If we are successful, I hope regulations are passed to control these emissions.

Haggett: Can I suggest another public policy question, which has to be asked even before the four questions you've mentioned? That is: Can it be studied? We may be in a situation where we have the most fascinating problems, where we either lack the theory or the data to study them.

Greenberg: A very astute question. In this case, there is plenty of theory, but limited data. I'll probably have a better answer to this question in a year or two.

Felson: If you complete thousands of correlations, I wonder how many of them are going to be found significant at a .05 level? There may be a problem of doing too much data analysis. Have you thought about doing statistical tests, not on the basis of a single statistic but on a set of statistics?

Greenberg: This is a very serious problem. If you run enough correlations, I guess something's going to turn up significant. To remedy this, we set up control correlations. For example,

the literature reports that the greater the population density, the stronger the association with certain types of cancer. So we use population density, as a control variable. In order for us to make an assumption that, let us say, percentage Hungarian population was perhaps causally related to a particular disease, that correlation would have to be higher than the population density correlation. We also use what I call a fall-back principle, based on general versus specific categories, such as total manufacturing, as opposed to chemical manufacturing. The literature suggests that there ought to be a relationship between the chemical industry and elevated risk of skin cancer. If we were to accept the chemical industry correlations, which might be fairly strong, they must be significantly stronger than the total manufacturing correlations. The question, in short, is an important one, and although I cannot answer it perfectly, I have used a variety of procedures to avoid spurious associations. A full presentation of these would take several hours.

Felson: Another problem concerns me. I wonder whether the basic epidemiological work with which you are finding consistency, has the same biases and lack of control. If there are spurious correlations in this literature, you may replicate them on a different level of analysis. There are certain relationships that may have been proven effectively, but there are

others which may have suffered from the same problems you are facing.

Greenberg: You can, in fact, replicate spurious correlations. On the other hand, sometimes the literature reports one sort of expectation and you turn up with something different. These correlations, in particular, deserve more careful scrutiny. The literature may be correct, you may be correct, or you both may be, because one or both are exceptions.

L. Brown: The problem you refer to is partly an establishment problem. That is, one group of people may have a stake in a certain finding. You said that in your research you consulted with several epidemiologists, but that you didn't necessarily feel their presence was essential. This is one way, at least in part, of getting around what I call the establishment problem. People are coming in with a different perspective, looking at the data with fresh eyes.

Boyce: There is a related establishment problem that I want to mention. One way you use your results is to publish them in academic and professional journals after they have been released. In this field, there is a severe establishment problem, with regard to getting results published which do not coincide with the establishment people. Have you encountered or expect to encounter this problem?

Greenberg: I expect to encounter it, but as yet, the state hasn't released the results of our first study. They have their own political problems and are under far more pressure than I. So I expect a continuing problem of this sort. Our contract specifies that in no way can the state prevent us from publishing the results of our study and I feel that they will be published.

Broadway: Do you anticipate opposition to public policy building based on your identification of individual plants producing excess carcinogenic substances?

Greenberg: Yes, absolutely. Many believe that when the State sends out the 12,000 questionnaires it is going to be sued. Therefore, the third study that I mentioned in my opening remarks may grind to a halt for a period of six or eight months until a court decision is made. I probably will have to testify about the security question: Can I, in fact, keep this data secure?

Nystuen: This brings up an interesting geographical specificity problem. With small-scale census data, we find that disclosure laws prevent information from being published. It sounds like you're in a highly specified geographic situation; don't you think the courts are just going to stop you from publishing many of your findings?

Greenberg: The Health Department has the names and addresses of all cancer mortalities for the period of 1962-1975 which, of course,

they are not allowed to divulge. Yet their maps are at a very fine scale; indicating where a person lives, the location of wells, and the location of factories. Likewise, I believe that most of our study's findings will eventually be reported at a scale adequate for public policy use.

Geographic Aspects of Clean Water Legislation in Southeastern Michigan

John D. Nystuen

I would like to describe several aspects of the Detroit Metropolitan area's response to the Water Pollution Control Act of 1972, and some of the problems faced by this area in attaining fishable and swimmable water by 1983, as is required by the Act. This case study provides an example of how decision makers in a complex system like the Detroit metropolitan area can pursue a clear cut goal such as clean water, when it is so difficult an intellectual task to understand how the system works. The Water Pollution Act, Public Law 92-500, also has some very interesting geographical characteristics which influence the control mechanisms capable of producing clean water.

Public Law 92-500 fundamentally changed public policy towards clean water. The most significant change was that the Act focused on reducing discharge of pollutants into the public waters instead of attempting to lower pollution levels in those waters; that is, dilution became an unacceptable public policy. This allowed policy makers to concentrate on point sources of pollution. A two-level approach was taken.

First, the EPA had to define acceptable levels of pollutant discharges. This required statements of the standards and negotiation with the various industries. If an industry didn't approve of the standards, it had recourse through the courts, as did environmentalists and other groups. Thus, establishment of the standards was an arduous task.

Second, local agencies had to be organized to issue permits on point sources. This has been accomplished to a great extent already and has involved an enormous amount of money. Currently, there are some 65,000 permits for point source discharge from industry and municipalities in effect throughout the nation. This policy is working mainly because point sources have geographical coordinates; that is, they fall inside property lines. Thus, if you can identify a point source of discharge into public water, you can identify the owner and make him responsible for it. Previously, public agencies would test public water, perhaps find it polluted, but not be able to identify a cause and effect chain to explain the pollution.

Another part of the Act addresses non-point pollution such as run-off from streets, storm sewer run-off, and run-off from agricultural fields. However, non-point pollutants cannot easily be assigned geographical specificity, and therefore the responsibility for them is also difficult to assign. Yet non-point pollution sources are significant. If the Act is going to achieve its goal, those responsible for local implementation need to establish area-wide planning and some mechanism for policing the non-point pollution.

The Detroit metropolitan area is a complex system containing 4.8 million people, in a seven county area with 300 municipalities and thousands of factories. The natural environment is also complicated, containing several water basins with different flow characteristics and the Detroit river which brings water from Lake Huron into Lake Erie. There is not only great complexity within the area but there are also

very strong external connections that make it difficult to see how Detroit will be able to handle the pollution problem.

There are some interesting geographic elements in the kinds of controls or filters that have been applied to the system. The EPA, for example, declared that storm sewer outlets were not point sources, basically for budgetary reasons. The EPA asked each municipality how much money it needed to spend on more secondary treatment, new interceptors, new septic sewers, additional control of storm water and so forth to meet the clean water requirement. In 1974, the total need exceeded \$480 billion to meet the requirements of the law, of which \$329 billion was for control of storm water run-off. Congress, however, allotted only \$18 billion for this task. By deciding that storm water outlets were not point sources, the EPA was able to strip \$329 billion off of the first round of estimates, thereby defining itself out of the problem. In 1976, using similar techniques of administrative squeezing and jockeying, all categories were reduced to the point where they now think that municipalities need \$96 billion, only 10 times more than the available funds (Figure 2).

The disparity between "wants" and "availabilities" is a consequence of the difference between local and global viewpoints. One device bureaucrats use to bring these views into balance is to define problems as being outside their jurisdiction. This procedure is not always to be despised. If a local "want" list is called for, subsequent trimming will be exposed to open debate in a political forum. This may be a reasonably fair way to pare a program down to workable dimensions.

Needs Category:	1974 Needs Survey	1976 Needs Survey	Percent Difference
Secondary treatment	17.81	13.0	-27
More stringent treatment	22.24	21.3	- 4
Infiltration/inflow	7.42	3.0	-59
Replacement and/or rehabilitation	10.25	5.5	-46
New collector sewers	24.58	17.0	-31
New interceptor sewers	25.27	17.9	-29
Combined sewer overflows	43.51	18.3	-58
Subtotal	151.08	95.9	-37
Control of stormwater	329.0	54.1	-84
Total	480.08	150.0	-69

Source: Environmental Quality -8th Annual Report of the Council of Environmental Quality, U.S. Gov't. Printing Office, December 1977 (p. 33).

Figure 2: Comparison of 1974 and 1976 Needs Surveys
(in Billions 1976 Dollars)

A second type of spatial filter influences application of the Clean Water Act in Michigan. It is applied by the Michigan Municipal Finance Corporation, the agency that reviews all borrowing of public corporations. They have the regulatory power to prevent a public entity from borrowing an amount that is more than 10% of the value of all assessed real property in the entity's jurisdiction. As the Water Pollution Control Act provides 75% federal funding, small units lacking intensive real property development cannot come up with the required 25% matching funds. Money is thus blocked off at that scale of public entity. This was necessary, in part, because of the potential for spending billions of dollars in outlying suburban townships in the Detroit metropolitan area which hoped to extend their existing sanitary sewer systems and their storm sewer system in order to make their land prime for future residential development. Federal programs involving spatial income transfers must be buffered against committing funds to certain places for hoped for development. There is no end to hopes for the future.

We need a good sense of the spatial and temporal characteristics of public policy instruments in order to come up with a workable control process in a system which we don't really understand. I think geographers can play a considerable role in this kind of analysis if they will pay attention to the spatial and temporal attributes of public policy.

Monk: You said the EPA eliminated storm sewers as point sources of pollution with respect to this Act. Has EPA decided that storm sewers are no longer a problem?

Nystuen: No. Environmental groups sued the government for making that decision, and the government lost in court and was required to consider storm run-off sewers as point sources. One of the keys to handling complicated regions is to have several feedback channels involving adversaries, technicians, and so on. Eventually you come up with something that works.

There is a tendency for politicians to handle the problem of cleaning water by building installations, more buildings, more infrastructure. Yet there are other routes, such as regulation where you deny the use of phosphates in detergents. Or you can go to a program of street cleaning. One of the problems is that big storms occur very infrequently, and when they do they wash the streets off. All the pollutants that have been piling up on the ground are suddenly dumped into the streams which then reach critical pollution levels. Thus, one might put money into street cleaning instead of bigger sewer holding tanks. There are other routes, which this impossible financial situation forces people to start thinking about. The regulatory route is not as expensive as building new facilities.

Roepke: Is that true, John, or does it merely transfer the expenses? One regulatory route is to shut down half the industry. That would clean up the waters in a hurry, but of course, then nobody has a job, they don't eat anymore, etc. I'm just wondering if it doesn't obscure the cost more than it reduces it.

Nystuen: Well I am not advocating that the regulatory route is always the way to travel. My notion is that you need a kind of thinking that is not very academic. What you worry about is advocacy in a public forum, which pulls you quite a way from our traditional type of analysis.

L. Brown: On the chart that you showed us summarizing the difference between 1974 and 1976 needs there were considerable reductions across the board (Figure 2). Were those reductions largely a result of redefinitions?

Nystuen: Most of the difference is due to redefinition and more stringent rules on how to estimate budgets. Some double counting was eliminated. In addition, \$8 billion in projects were approved between 1976 and 1978.

M. Brown: Is there any hope that local governments will be able to control pollution in their communities to the degree required by the Water Law?

Nystuen: I don't know yet. I know that the mechanism they're setting up in the Detroit Metropolitan area relies on the Southeastern Michigan Council of Governments, and an area-wide water quality board to monitor the program. These are terribly weak mechanisms.

Yeates: It's all very well to write a regulation and put a law into effect, but maybe behind the scenes public policy is that the law shall not be put into effect by allocating its operation to a very weak agency.

Nystuen: That's definitely a mechanism that most of the municipalities are trying to adopt, because they would prefer to have the control for themselves. They don't want an area-wide water quality board, they would rather have the Michigan State Natural Resources Department monitor the Act. The municipalities know that it is more difficult to reduce the budget for pollution inspection if the monitoring agency's only mandate is to inspect.

Yeates: Geographers and particularly those concerned with environmental protection should be interested in the way that public policy is implemented and monitored. This raises a very general question: To what extent should academics or geographers be involved in monitoring work that is ongoing? Very often you don't have the funds to do that, although quite often you do have some private research time.

Nystuen: I know something about the monitoring of this Act because I'm on one of the five citizen boards that were mandated by the federal clean water act to oversee the planning process. I can stir things up a little bit in that capacity, particularly if by getting my students involved I can come up with a good analysis.

Greenberg: I agree that geographers should try to be involved in this and should try to get their students involved, too. For example, I found it rather strange that in some places the air quality

improved in two years. Upon sending some students to look at the pattern of air quality monitoring stations, we found that one way to improve air quality was to change the location of the stations. It's a very interesting technique, and it worked rather well.

Innovation Diffusion in a Public Policy Context

Lawrence A. Brown

The question of the relevance of social science research to public policy formulation is a common one, but its consideration frequently generates more skepticism than confidence. Rein and White (1977), for example, state that

....in all the large domestic agencies there are now centers for policy planning, management, and evaluation(but)....along with the growth of research, which is often mandated by the legislation that institutes new social policies, there has grown a chronic sense of frustration, among both those who carry out the research and those who commission it. The feeling is that research does not really serve to guide policy, or is misused, or lies on a shelf unused. Has the contribution of research to action been oversold? (p. 120).

Harvey (1973) elaborates on another side of the problem, which in part explains its existence:

There is a clear disparity between the sophisticated theoretical and methodological framework which we are using and our ability to say anything really meaningful about events as they unfold around us. There are too many anomalies between what we purport to explain and manipulate and what actually happens. There is an ecological problem, an urban problem, an international trade problem, and yet we seem incapable of saying anything of depth or profundity about any of them. When we do say anything it appears trite and rather ludicrous. In short, our paradigm is not coping well (pp. 128-129).

It is not surprising, then, that the marriage between social science research and public policy is one frequently proposed but seldom consummated.

I would like to use these quotes as a backdrop for discussing innovation diffusion research and its public policy context.

First, I will discuss innovation diffusion research and its policy relevance. Then, I will raise some general questions about social science research and public policy.

Research in the area of innovation diffusion is particularly interesting since it has been directly employed in formulating diffusion strategies by public agencies such as the Cooperative Extension Service in the United States and family planning programs in the developing or third world. My own research focuses upon the ways innovations are made available by public and private agencies to potential adopters. Two steps are involved: establishment of diffusion agencies through which the innovation is distributed to the population at large, and establishment of the innovation which involves implementation of diffusion agency strategies to promote the innovation (Figure 3).

These processes are imbedded within a set of preconditions for diffusion. One of these preconditions is the invention of the innovation itself. Further, however, the innovation is tailored to varying markets, and this tailoring itself will affect the spatial and temporal patterns of diffusion.

There is yet another aspect of diffusion: the impact of the innovation upon society or the economy. This is termed the development perspective on Figure 3.

Public policy concerned with the diffusion of innovations has largely employed an adoption rather than a diffusion agency perspective. This is most evident in the programs of the Cooperative Extension Service of the United States and in family planning programs of third world nations.

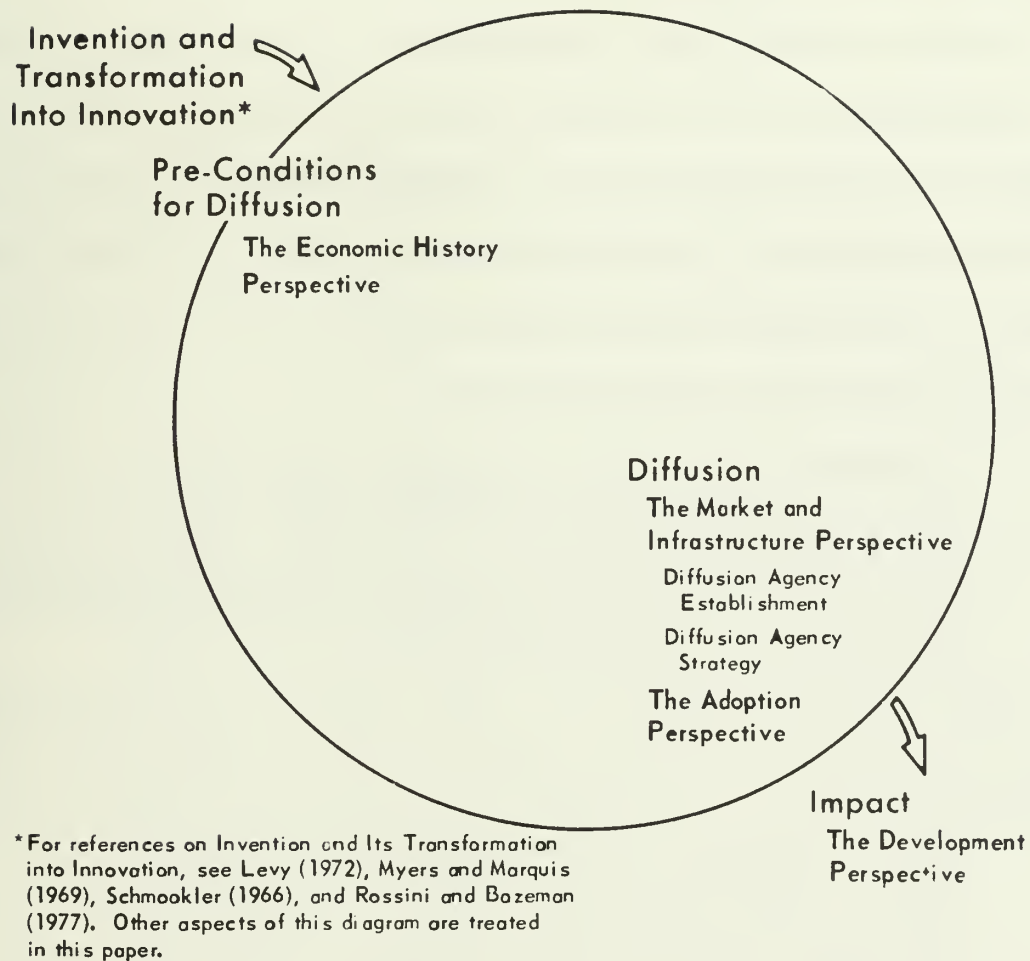


Figure 3: The Innovation Diffusion Process in Terms of the Perspectives from which it has been studied

Reliance upon the adoption perspective is indicated by the emphasis on communications in the diffusion strategies of most public programs and in the marketing professional's treatment of innovation diffusion as a problem in consumer behavior.

Despite its prevalence, the adoption perspective has been questioned as a cornerstone for the design of diffusion programs. This is in part because of the ineffectiveness of programs designed on the basis of the adoption perspective. For instance, Brown, Maxson, and Brown (1977) note about the Eastern Ohio Resource Development Center, a diffusion agency for the Cooperative Extension Service:

....nearly 20 percent of the sample had adopted none of the six EORDC [recommended farm] practices... the average person had adopted less than one-half of those practices applicable to his or her farming activities, and....only 18 percent had adopted more than two-thirds of the applicable recommended practices (pp. 22-23).

This is not very impressive. With regard to family planning efforts, Weinstein provides the following from the New York Times of August 6, 1973:

India's soaring birth rate has been unchecked by family planning drives in recent years. There are 57,000 Indian babies born daily....Originally the Government's target was to reduce the birth rate from 41 per thousand population in 1968 to 25 by 1976. The government now has extended the target date to 1980. The birth rate is now 38 per thousand.

To place this observation in perspective consider that

The government in India in 1952 was the first in the world to adopt family planning as a national policy. No other nation has received so much money, technical assistance, and equipment from the family planning establishment. And no other nation spent so much of its own funds on family planning (Demerath, 1976, p. 59).

My own view of this particular example of the marriage between social science research and public policy is one of excitement and optimism rather than dismay. There has been a distinct evolution in diffusion theory in a manner that is congruent with the expressed concerns of the practitioners and the recognition of shortcomings in programs of innovation diffusion. Thus, the applicability and effectiveness of diffusion theory has increased at the same time that practitioners have recognized the need for reviewing and reformulating programs of innovation diffusion. The result should be a change in these programs with a concomitant opportunity to test our new thinking about innovation diffusion in a real world laboratory to which social scientists rarely have access.

There are many public policy areas in which geographers studying innovation diffusion research can make a contribution. One of these is the design of public and private diffusion programs. For instance, geographers have considerable skills in designing and implementing location-allocation frameworks and these can be employed in rationalizing the establishment of diffusion agencies. Geographers also can (and have) contribute more generally by viewing diffusion from the perspective of the agency, as a problem of logistics, distribution, and promotion, rather than from the traditional perspective as a problem in consumer behavior.

Geographers can also contribute to analysis of the impacts of diffusion agency programs on social welfare. This impact has been shown to depend upon the innovation being diffused. In a third world setting, for example, there is a landlord versus peasant bias for many innovations, and hence

for many diffusions. There also are locational biases related to the infrastructure requirements of an innovation. Cable television, for example, depends upon the placing of cables, and typically these cables go first into upper-middle-class neighborhoods rather than lower-class, black or other areas. It appears, therefore, that people with certain social, economic, demographic, and locational characteristics are continually and consistently benefiting from diffusion programs.

Although geographers can make major contributions in design of diffusion programs and analysis of their impacts, they are frequently reluctant to ask such policy relevant questions. They are not accustomed to addressing applied questions such as "how should the market be segmented for diffusing condoms," and "should it be done differently for pills?" In addition, many researchers and funding agencies lean towards a quantitative methodology which concatenates with and promises to extend general theory. Yet this quantitative emphasis does not always seem appropriate for policy formulation regarding innovation diffusion. A more suitable methodology might render a more central role to qualitative analysis and a case study approach allowing general principles to emerge inductively.

Now with this discussion of innovation diffusion in mind, let us return to a broader perspective and consider again the quotes of Rein and White (1977) and Harvey (1973). Why do academics or geographers run into trouble in the policy arena? Here are some of my thoughts on this question.

First, in policy analysis, no one really has the answers. Policy research and formulation strikes me as a six-blind-men-and-the-elephant

routine. If some people play more of a role in policy than others it is because of their institutional role (e.g., as a government agency), not because they know more. Yet this ~~six-blind-men-and-the-elephant~~ routine has a dialectic through which we generally achieve a higher level of understanding. Innovation diffusion and location allocation research is evidence of this.

Second, policy problems often become redefined under us and that redefinition in many instances simultaneously defines failure or (rarely) success in ongoing programs. For instance, unanticipated effects may emerge, as in public housing programs with a bulldoze and build high-rise philosophy. Shifts also occur in the broad goals of society and in the problems deemed important.

Third, as social scientists, there is a limit to the level of complexity we are capable of understanding, particularly if we remain within the limits of our traditional models and research techniques. Thus, there is often a significant gap between our models and the reality they purport to portray. Location allocation models, for example, do not portray the political actualities of public facility location decisions. Yet, it also must be said that our models today are better and closer to reality and partial approaches may be all we can hope for.

Fourth, the quotes by Harvey and Rein and White are also the result of a "scale of problem" problem. If we as social scientists are given a specific task to which we are to find a solution, we do okay. However, when social scientists attempt to define solutions to broad problems such as poverty, we don't do very well. If it's any solace, I don't think anyone else does well here either.

My response to this problem might be summarized by something I said earlier in this talk. As an academic both involved in innovation diffusion research and concerned with its relevance, I find this situation healthy rather than disconcerting. First, there is a dialogue between research and application. Further, there has been a distinct evolution in diffusion theory toward research which is more congruent with the expressed concerns of practitioners and recognition of shortcomings in programs of innovation diffusion. Thus, the applicability and effectiveness of diffusion theory has increased at the same time that practitioners have recognized the need for reviewing and reformulating programs of innovation diffusion. I think these observations apply to geography in general, and not just diffusion theory.

Getis: The desire of academics to solve "societal problems" tends to make them adjust either their way of thinking or their academic path every year or two, in order to solve public policy questions. Particularly in geography there seems to be a tendency to leave a lot of problems behind; we're constantly shifting and not attempting to perfect the techniques and theory developed in earlier periods. In a sense, this is a corrupting influence on our academic goals of learning and understanding.

L. Brown: Yes, I agree. In addition, our concern in the 1970's with relevance and policy has led to a lot of inane statements by people who have never thought much about policy before and think somehow that their simplistic notions of the world are applicable.

Broadway: I would question, actually, the notion that geographers have ever really dealt with real world situations. If they have, they never have communicated their results to society at large and have never, therefore, had much of an impact.

L. Brown: Yes, I think there has been a schism between theoreticians and applied people.

Roepke: I think Mike is right, most geographers are not dealing with real-world situations; and I think Art is right, there's a lot of flitting around. I'd like to suggest that a good deal of the newly found interest of geographers in public policy and in relevant questions results from a desire to drum up some research dough rather than a real interest in public policy and solving problems.

L. Brown: There are fads in social science and now we're in a "relevance" fad. Of course we don't call it a fad, we call it a serious concern for the discipline. In terms of the mass of the discipline, however, I agree that there's a lot of hopping on the bandwagon.

Felson: We have a situation where the government demands information and it demands models to deal with policy issues. Good or bad, they're going to get models, and social scientists presumably will be providing many of them. I believe we need a group of protected quasi-policy researchers, insulated from day-to-day politics. You can't have everyone committed to providing

immediate applied research and subject to political pressures such that no one has time to think about the issues or to speak freely.

Nystuen: Has any work analysed the inequities created by innovations?

M. Brown: We have examined who public agents focus upon in disseminating information and other adoption incentives. We found that many public diffusion programs focus upon "opinion leaders" (i.e., the wealthier and better educated segments of a population) hoping to accelerate innovation diffusion through the two-step flow of communications (diffusion agent to opinion leader to potential adopter). Yet this type of market segmentation policy would seem to increase income and welfare inequalities.

Nystuen: Then the question becomes: Would you recommend that such a model be used?

L. Brown: Well, again this comes to the scale of problem input. Someone's got to define what we are trying to do in a particular innovation diffusion program. Are we, in fact, trying to favor certain people? Is it true that if a certain group of people achieves a certain economic level, the economic level of others in the population will also improve? Ought we to concentrate our development resources on a specific group or a specific location or ought we to spread them more evenly? These are general questions that social scientists including geographers have trouble addressing. Perhaps this problem is

related to the uncertain role the academic plays in setting policy goals. Do we try to influence goals or do we only do research?

Literature Cited

- Brown, M.A., G. E. Maxson, and L. A. Brown. 1977. "Diffusion Agency Strategy and the Adoption of Infrastructure Independent Innovations: A Case Study of the Eastern Ohio Resource Development Center," Regional Science Perspectives, 7: 1-26.
- Demerath, N.J. 1976. Birth Control and Foreign Policy: The Alternatives to Family Planning. New York: Harper and Row.
- Harvey, D. 1973. Social Justice and the City. London: Edward Arnold; Baltimore: The Johns Hopkins University Press.
- Levy, G. W. 1972. The Interactions of Science and Technology in the Innovation Process: Some Case Studies. Washington, D.C.: National Science Foundation.
- Myers, S. and D.G. Marquis. 1969. Successful Industrial Innovations. Washington, D.C.: U.S. Printing Office.
- Rein, M. and S. W. White. 1977. "Can Research Help Policy?" The Public Interest, 49: 119-136.
- Rossini, F. and B. Bozeman. 1977. "National Strategies for Technological Innovation," Administration and Society, 9: 81-110.
- Schmookler, J. 1966. Invention and Economic Growth. Cambridge: Harvard University Press.

Public Issues Resulting from Urban Growth in Southern Ontario

Maurice Yeates

If recent publications are anything to go by, I would judge that Canadian geographers have decided that they are not going to be reticent about discussing matters of public policy in areas in which they feel they have some competence. My particular concern for today began when the Ministry of State of Urban Affairs, a small ministry in the federal government asked me to write my own view of urban growth in the area between Windsor and Quebec city, and to suggest some concerns of a national, macro-regional and local nature. This was, thus, a very large request. I decided that I'd complete the task in one year, and the results have been published in my book Main Street: Windsor to Quebec City (Toronto: MacMillan of Canada, 1975, 1976).

The area that I'm concerned with is about 750 miles in length, between Windsor and Quebec city, and contained about 12 million people in 1971 (Figure 4). It's an area of particular concern to the government because it straddles both Ontario and Quebec. According to the British North America Act, the federal government has no power over municipalities in Canada. Nevertheless, the federal government did feel that it had a legitimate interest in the urban outcome of national growth. The written directive was to analyze the extent to which this area in central Canada dominates Canada, how this domination reveals itself in urban growth and urban expansion, how the area is changing, and what important issues are resulting from this urban growth and expansion.

One of my first tasks was to analyze past trends, particularly in

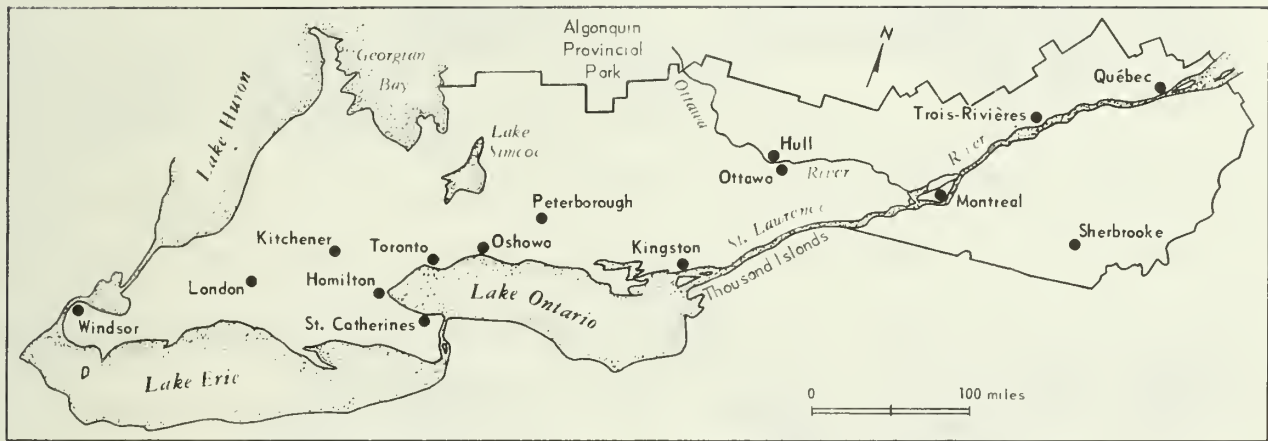


Figure 4: The Windsor to Quebec Region

population growth, to look at the determinants of growth using a demographic approach and then to predict future characteristics of this area, if these trends continue. We developed a scenario for the future population of major regions of the country on the basis of the four key factors that determine population growth in Canada. Birth and death rates were examined using a model which projected them into the future for subareas of Canada. We looked at internal migration, by dividing Canada into major regions and examining interregional migration. Finally, we tried to take into account the destination of immigrants—which is an important issue since a large proportion of Canadian total population growth (25% over the last 15 years) has come from immigration from abroad. Of course, regulation of immigration is a definite policy lever government can use if it wants to control rates of growth.

We also looked at projections for major and minor subareas located between Windsor and Quebec city. Then we used a modified version of the Curry-Bannister spectral model with the subarea projections as constraints to the allocation of population. We barreled it on into the future, and predicted that this is how the region between Windsor and Quebec city will look in the year 2001 (Figure 5).

Now then, what were the public policy concerns that came out of this? First of all, this area within Canada, which is 85% urban, contains a disproportionate share of the population of the country (53%) and 70% of its manufacturing. One great concern of other parts of Canada (such as Alberta, British Columbia, Saskatchewan and the Maritimes) is how this concentration came about and whether some of this economic activity could

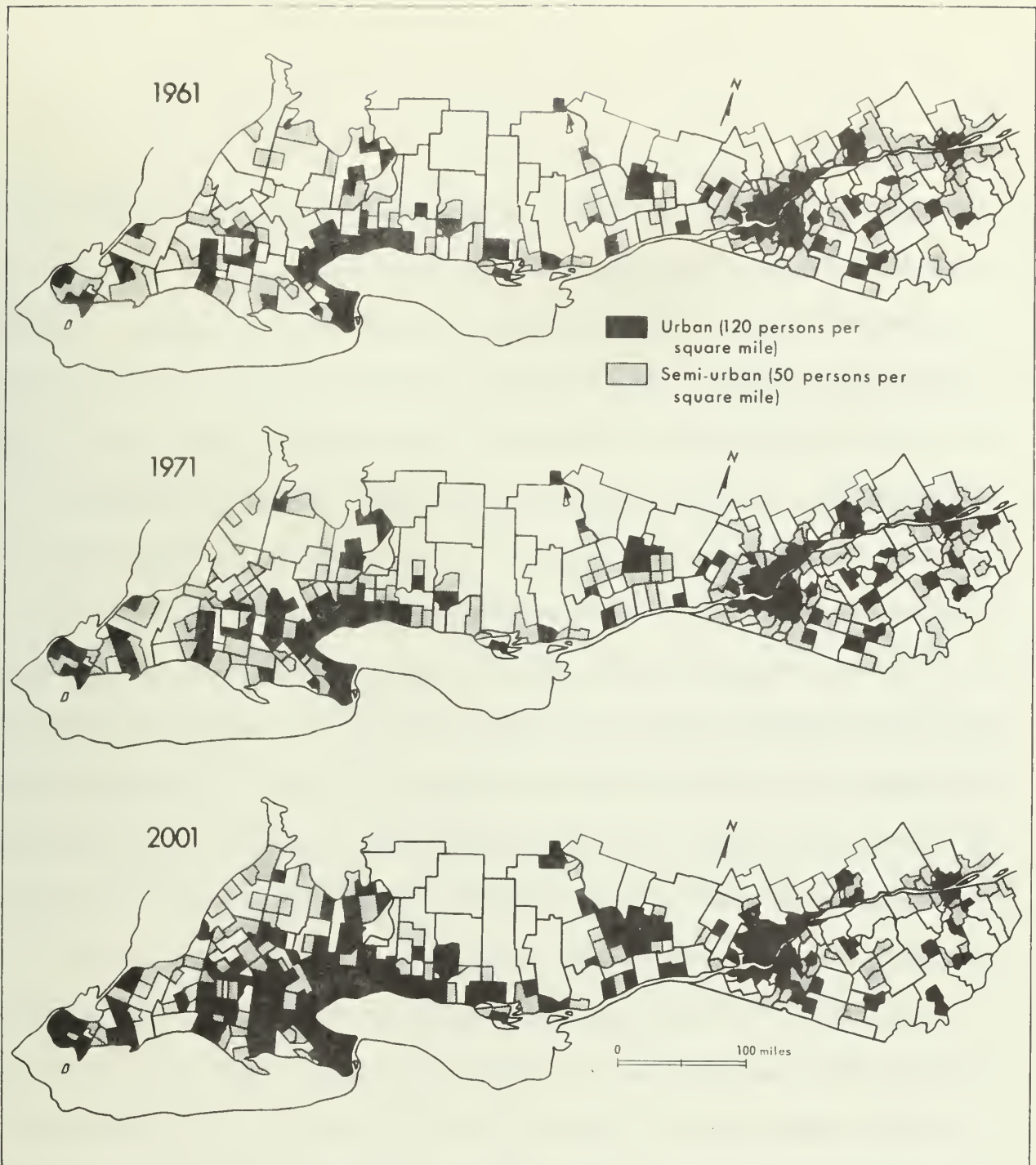


Figure 5: Main Street in the Years 1961, 1971, and 2001

be deconcentrated out to them. We employed a traditional and a non-traditional approach to answer these questions.

The traditional approach looked at transportation costs. Toronto and Montreal are the centers of the arterial network of the country. Thus, freight rates on raw materials and partially manufactured products favor shipment to Central Ontario for manufacturing. Of course, geographers can make a big impact here by employing what they know about transportation and the location of industry.

We also looked at this region in terms of dependency theory, which is a nontraditional approach. Central Canada has managed, through the workings of the urban hierarchy to impose its control over the hinterlands. This perspective hasn't been discussed much, although it is beginning to be recognized by some of the provinces, particularly Alberta, now that that province has more economic power.

What sort of policies might be adopted? If you analyze the way in which growth has occurred, both within the axis and in the rest of Canada, it becomes obvious that a great deal of the growth in employment has come from growth in tertiary industries such as governmental activities. Whereas the federal government closely monitors the location of private industry and manufacturers, it has not looked closely at its own activities to see how much they might be decentralized. One recommendation, then, was that the federal and provincial governments look at their own activities and see how much they might be decentralized as a way of managing urban growth in certain areas. And of course, geographers could contribute a fair bit to such an analysis.

Three actions of interest, by happenstance, resulted. First, the federal government almost instantaneously decided to decentralize the Department of Veterans Affairs to Charlottetown, Prince Edward Island. To show that it recognizes the existence of a hard-core group of geographers in Ottawa, the Map Branch is scheduled to move from Ottawa to Sherbrook, Quebec. Third, in the province of Ontario, the offices administering the Ontario Hospitalization Insurance Plan are scheduled to move to Kingston, Ontario to maintain growth there.

Further policy recommendations grew out of an analysis of the consumption of land. If land consumption rates continue to increase as they have been in the immediate past, there will be another approximately 2000 square miles of urban land in the axis in the year 2000, over and above the approximately 2000 square miles of urban land that already exists. We looked at the subareas where this land consumption was going to take place and found that the land we are going to use primarily will be around Toronto and St. Catherines on what happens to be the best land in Canada. This is an important issue in Canada because the country has very little class 1 land, land that is highly fertile and in a good climate. Geographers have been very interested in this problem in Southern Ontario, and have focused their research interests heavily on the land issue. Public policy issues resulting from this have dealt with regional government reorganization in order to find some level of government that is capable of planning in the regional context.

Another policy issue pertains to the duality between Montreal and

Toronto, which are always expected to be about equal in size and power. Yet, if one examines the growth of Canada, by the year 2000 Toronto becomes easily dominant with 6.6 million inhabitants compared with 4.5 million for Montreal. The issues arising here relate to the degree to which the French Canadian people are prepared, in effect, to have Montreal subserviant in the urban hierarchy to Toronto. This is an important issue which geographers in the province of Quebec were very quick to realize.

Finally, there was a transportation policy issue: what type of transportation should this area have for what amounts to a linear distribution of population. Here we discussed the trade-offs between air and rail transportation. The Ministry of Transport in the federal government has considerable investment of people and planning in the construction of a new airport in Toronto, and in the construction of short take-off and landing facilities in this area. Yet most independent studies favor high-speed railway transportation within this area, a position I support.

These are some of the issues that came up. I hope I've given you a flavor of the public policy questions that we looked at; some of them in depth like the urban land conversion issue, some of them more peripherally like the transportation issue, and some I haven't even mentioned here like the restructuring of local government.

Greenberg: To what extent are environmental impacts of alternatives considered to be important by the government and by you?

Yeates: The environmental impact of urban growth is considered to be quite important; the consumption of land, in particular, is

a big issue because we simply don't have much good land to squander. If we build over it now, we won't have it for the future when we're going to need to produce on it. The question of environmental pollution is also of great interest to the government. One of the studies that we have at Queens University is funded by a substantial grant from the Canada Center for Inland Waters. We are looking at the impact of urbanization on water quality and stream run-off in all the watersheds tributary to the Great Lakes on the Canadian side.

Getis: In Canada there is the major political question concerning the people of Quebec that will no doubt affect any projection to a very large extent. The question is, do we proceed to make estimates, when we know that there is a very high probability that political developments will result in our having to make huge alterations to our prognostication.

Yeates: We do because we can then give some measure of the import of that political question. For instance, we are able to say about the Toronto/Montreal issue, that the situation in Quebec has accelerated the trends that would have taken 20 years to happen in just 3 to 5 years.

Williamson: Do you have any results which give policy-makers guidance as to what would happen to population projections if they controlled the one migration they can control, which is across national boundaries?

Yeates: There's a big debate going on right now concerning what might be the impact of controlling immigration, and geographers are taking a major role in it. For instance, there is the inner-city, outer-city question. In Canada, we have fairly healthy inner-cities, and one reason is that we've had a high rate of immigration which has provided new people for the inner-cities. If we reduce the amount of immigration, what impact would this have on the inner-city? By building a model of the kind which includes migration from outside and migration from inside, you can begin to get at some of the issues that might result if you dampened these flows.

L. Brown: It seems to me that you and Peter Haggett are in different settings from us, settings where geographers have a traditional role in policy analysis. Geographers are frequently included in high-level positions in planning and such, whereas this is not so true for geographers in the U.S. What kinds of differences do you think that creates in terms of your own particular exuberance for the role of geographers in policy analysis?

Yeates: The role of geography in Canada, the United Kingdom, and many European countries is quite different to that of geography in the United States. Geography is accepted as having some useful things to say about economic and urban questions, and those of a more physical nature. But it's been the fertility of graduate schools in the U.S. that has provided the discipline with many of its most useful ideas. We are in a position to use

many of these ideas and theories in the public policy arena more easily than our U.S. colleagues in the profession.

Comments on the Role of Geographic Analysis in Public Policy

Peter Haggett

Not having read what the speakers were going to say beforehand, I think it more useful to comment on where I see public policy fitting into a general research activity. In order to do this, we can look at a matrix of research categorized by type of problem and type of solution (Figure 6).

Research problems can be conveniently divided into three categories: internal (or academic) problems, and external (nonacademic) problems. The latter may be either well-defined or poorly articulated. Well-defined problems tend to be technical in nature, while major social and political problems tend to be poorly articulated.

Solutions can also be divided into four categories. They may be: known; unknown but assumed to be knowable; unknown and assumed to be unknowable; or unknown but assumed to be knowable. Solutions are assumed to be knowable when we see where the solution might lie and how it might be uncovered, given adequate research resources. Solutions are assumed to be unknowable when we do not know of any scientific way of approaching the problem.

First I would like to discuss the various solutions to academic problems. Known solutions to academic problems are often studied in university training programs, where we may want to examine again and again something for which there is an answer in the back of the book. Solutions which are unknown but assumed to be knowable are often studied

		<u>Type of Problem</u>		
		Internal (Academic)	External (Nonacademic)	
			Well-Defined	Poorly Articulated
<u>Type of Solution</u>	Known	Training	Institutional Research	
	Unknown but knowable	Basic or Pure Research	Applied Research	
	Unknown and unknowable	Philosophy	Public Policy??	
	Unknown but assumed to be known	Dogmatics		

Figure 6: Matrix of Research Activity

in pure or basic research. Where the solution is unknown and assumed to be unknowable, research involves philosophy (e.g., questions of balance and equity or of purpose and meaning). Although no solutions exist for these, each new generation asks them again and again. Solutions which are unknown but assumed to be known rely on dogmatics: it may be easier to strongly believe in the solutions than to demonstrate them in any logical, formal process.

I am much more familiar with research problems in the inner university world than the outer world of public policy. Yet one can easily characterize nonacademic problems with unknown but knowable solutions. Here we generally have well-defined public, technical problems studied through applied research. Where we have known solutions for well-defined problems, we have institutional research. Here solutions have been achieved, possibly through basic or applied research, and an institution applies these relatively well-defined methods to problems. A typical geographic example of this occurs when a mapping agency applies known methods of mapping to unmapped areas.

That, basically, is where I can complete my matrix. Now we must ask: Where does (or should) public policy lie? Does (or should) it lie in the application of technically known solutions towards poorly defined nonacademic questions, where the targets and goals are unclear. Or does public policy lie in the nonacademic portion of geographic dogmatics? Just like any finished piece of architecture, I'll leave you with only a few bricks completed, in the hope others will contribute to the final structure.

Boyce: It seems to me that public policy involves poorly articulated problems, where solutions are unknown but knowable. Whenever I go out and work on public policy problems, again and again I find that we don't know the solutions. Not only can we not define the problems well, but we wouldn't know the solutions if we could. Of course, there is circularity there. After those kinds of experiences, I'm often right back to basic research. Of course, there are public policy problems to which solutions are known, but I would say that those are not so poorly articulated. They are implementation problems or what you called institutional research. It seems to me that there are some really interesting external problems requiring basic research.

Haggett: David's remarks bring up a series of follow-up questions as to exactly where the burden of university research should be. To some extent, government organizations are now assuming quasi-university functions in terms of basic research, and the traditional separation is getting blurred.

Nystuen: This may be because the academic's involvement in public policy is fraught with difficulties, both personal and political. Nevertheless, academics should be placed out in the right-hand side of the diagram.

- Yeates: Yes, you might have your fingers burned working in the policy area. The university must reward academics for dealing in public policy in order to make it worth their while.
- Haggett: But doesn't academic tenure provide "parliamentary privilege"? That is, it allows academics to deal in "hazardous areas."
- Boyce: Geographers who want to assert the role of the field must become involved in these poorly articulated problems. One incentive is that these poorly defined areas are exciting.
- Getis: One also becomes motivated to cross the line into public policy because students are demanding it. Then we frequently find ourselves unable to cope.
- Merrifield: The job market requires students to become involved in the policy field.
- Yeates: Geography programs do tend to give students an edge in the job market because of their breadth and interdisciplinary nature. Nevertheless, training should be provided in policy areas.

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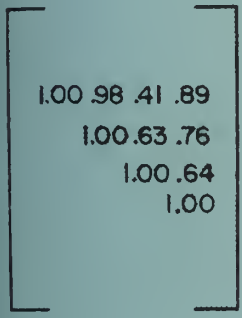
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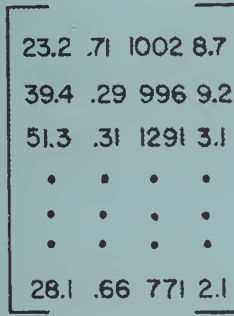
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AN INTRODUCTION TO FORTRAN AND THE PROGRAMMING OF SPATIAL DATA



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PAPER NUMBER 13
July, 1979

Editor of Occasional Papers: Rick Mattson

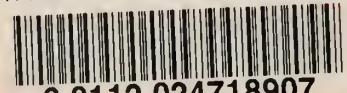
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