Chapter 1

A Brief Review of my Scholarly Contributions in Behavioral, Economic and Health Geography

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1.1 Introduction

I wrote this chapter on the occasion of my retirement from the University of Iowa. This juncture in my life seemed a good time to briefly review my scholarly contributions in the fields of Behavioral, Economic and Health geography during five phases of my professional life so far.

Space does not permit me to comment on the many things I learned from students, faculty colleagues, and many others with whom I worked. However, I would like to clarify Goodchild's comment in his chapter that Rushton's thinking was intuitive, not mathematical, and that I worried a problem to a solution [1]. All very true. The worry, I think, was to see the problem expressed in a way that satisfied me. The thought that always pushed my thinking was whether I agreed with the problem as others saw it, which was frequently where the problem lay.

For example, I recall a three-day meeting of specialists in location theory in the early 1970s. Michael Dacey, a prolific author of papers on central place theory at the time, stripped off the dust jacket of Walter Christaller's book [2] while standing before his audience. He waved the graphics of hexagons nestled one within the other saying, "I tell my students this is all you need to know about this theory". A

few minutes later, it was my turn to speak. Waving the same book, I said:

> "I tell my students these get all the attention when people write about this theory but, inside, you will find little discussion of this graphic. Christaller writes here about the behaviors of people as consumers and their behaviors as suppliers of goods and services; and he writes about how towns and service centers and their functions arise from the mutually adaptive behaviors of the two".

I had only recently reached the conclusion that Dacey and his many followers perceived a different problem of what about central place theory should be researched and what needed to be discovered.

Similarly, during a subsequent phase with several students when I was researching methods to solve heuristic location-allocation problems, I was less interested in finding better algorithms than in finding algorithms that solved for the kind of behaviors that consumers and suppliers engaged in. Later when I was researching spatial patterns of infant mortality and birth defects, I was less interested in assessing national patterns of mortality and morbidity rates, and more focused on finding robust patterns of rates at the clearest small-area level. In all three cases, I think what distinguished my approach was that I was defining the problem differently from others.

When I read the research of my former students and colleagues, I can now discern their further innovations in definition of a research problem. The remainder of this chapter hopefully provides a foundation for the research advances of my former students and colleagues in the nine chapters that follow in this book.

1.2 Behavioral Geography 1964-1970: Analysis of Spatial Choice and Revealed Space Preferences

My publications during a Behavioral Geography phase refined models of consumer spatial behavior to predict the places that people living in typical rural environments such as in Iowa would select to satisfy their needs for goods and services. This research began with an English translation of Christaller's 1933 dissertation that had become available in 1961 with a microfilm of Baskin's dissertation [2]. I studied this microfilm as a class project in an urban geography class with Professor James Lindberg at the University of Iowa. I was interested that Christaller payed very little attention in his book to the spatial-hierarchical arrangement of central places that he had deduced was a characteristic of the central places of Southern Germany. Instead, he focused his discussion on the respective spatial behaviors of people there in their roles as consumers and producers of basic services.

The literature of the early 1960s either focused on the geometric characteristics of central place systems or on the empirical study of activities in central place systems. I, however, focused on the behavior of consumers and how Christaller's central places systems emerged from changes in the spatial behavior of consumers and the reactions of producers of services to these behaviors.

At this time, I was a research assistant in the Bureau of Business and Economic Research (BBER) at the University of Iowa. The BBER was noted for market area analyses in which teams of students in the College of Business delineated the areas served by towns based on interviews with consumers. I contacted the director and suggested that these market area boundaries were surely predictable based on secondary data about towns, their contents, and their relative locations; see also Tom Bell's chapter in this book [3]. In my

opinion, the field surveys were inefficient and performed poorly, as very small local samples were ineffective for estimating the boundaries in question.

I ultimately hypothesized the use of spatial search algorithms and multi-dimensional choice functions to reveal how individuals evaluated potential places, and chose one place while constrained by personal, social and other factors. These revealed space preference functions in a spatial context ordered the alternative places from which a person could choose. Several areas of technical progress were needed to implement these ideas; see also Gordon Ewing's chapter [4]. Spatial searches of the places surrounding people required that persons and places be geocoded and that efficient search algorithms be constructed; the results of such searches needed to be captured and attributes of searched places needed to be linked; places chosen by individuals from their discrete alternatives needed to be ranked; and most challenging of all, a choice function needed to be found that would reconstruct the ordering of the alternatives given the personal characteristics of the individuals; see also Alan Phipps's chapter [5].

Several early publications were co-authored with Reginald Golledge and William Clark, with whom I worked after my stint at the BBER. Dr. Ron Boyce hired us to analyze some of the sample data on the household consumer behavior of the dispersed Iowa population.

An early incentive for my development of GIS was that most analyses depended on developing a geographic base file consisting of location coordinates of not only all towns and townships in Iowa, but also those of a random sample of farm and non-farm rural residents. With such a geospatial database first developed in 1963, I was able to write search algorithms showing not only the place chosen by the sample residents but also alternative places which they could have chosen but did

not choose. These publications and this methodology became widely adopted in subsequent research on spatial choice in the emerging field of GIS. This work culminated in my paper [6] that 15 years later received Classic status.

1.3 Health Geography 1971-1981: Spatial Patterns of Facility Locations and the Optimal Locations of Facilities in Iowa, Nigeria and India

A theme of publications with colleagues at the University of Iowa, and in institutions around the world during my first Health Geography phase, was that network-based location-allocation algorithms could be used with geospatial databases to measure the spatial accessibility of people in a system of service facilities. Another theme was the utilization of these algorithms to identify new locations for improving access to primary health centers, schools, marketing facilities, branch banks and other rural services. In India, in particular, the World Bank had begun to invest in improving the marketing facilities and the planning infrastructure for such services.

My research was assisted by collaborations in two externally-supported applied research projects. The first involved five short-term visits between 1971 and 1974 as a consultant to the Ford Foundation in New Delhi, India. The Ford Foundation was advising the Indian Ministry of Agriculture on a large project to bring scientific planning principles and methods of spatial analysis to the planning of rural services in India. The objective was support for access to essential services needed to advance the green revolution that had started in India in 1968.

The second project was with the Regional Medical Program (RMP) in Iowa, which was one of a national system of such programs designed to bring the benefits of advances in medicine to areas of the U.S. that were not part of the

medical revolution. In the Iowa RMP, I led a project on planning access to primary health and dental services in the state of Iowa.

In both projects I developed large geospatial databases that included finely geocoded measures of demand for health services with spatially geocoded measures of existing health resources. In both cases my colleagues and I developed heuristic location-allocation models and implemented them with the large spatial databases even though constrained by limited computer capabilities of the 1970s in Iowa and New Delhi. My interest in regional development theory and regional planning projects matured during this period (e.g., [7]).

1.4 Economic Geography 1981-1995: Decision Support Systems for Efficient Decision-making in Locating Public Facilities

The theme of my publications during a first Economic Geography phase was the development of measures of the cost to the public of suboptimal locations of facilities [8]. My research in Iowa and India in the 1970s had convinced me of the frequent occurrence of better locations than chosen ones for a wide range of activities. A better location was defined as a new location that had 'better' measures on all of the attributes that the decision makers themselves had stated were important. In practice, better locations were measured by location-allocation models applied to geospatial data of local areas. These algorithms had objective functions operationalizing decision criteria that decision-makers claimed were their objectives.

With two grants from the National Science Foundation, and with colleagues Michael McNulty from the University of Iowa, Vinod K. Tewari from the Indian Institute of

Management, Bangalore, Bola Ayeni from the University of Ibadan, we interviewed decision-makers in India and Nigeria who had been responsible for recent location decisions about health centers and public schools. Our spatial simulations confirmed alternative locations to those actually chosen would have performed better according to the multiple criteria expressed by the decision-makers. Also during this period, I visited projects being implemented by USAID in an attempt to improve rural access to services in developing countries, including the Philippines, Jordan, Israel, and Bolivia.

Microcomputers were becoming available, and so the efficiency of location decision-making could clearly be enhanced by taking microcomputers into the field and interacting with local decision-makers. Questions and answers could be asked and answered in real time with community involvement in the interaction. I did this in projects in India, Nigeria, Iowa and Australia. It was during this period, for example, that Michael Goodchild joined me in India where he began to program micro computer code to measure access to services in rural study areas.

I further developed these real-time computer-interactive spatial analyses in the presence of decision-makers for enhancing the quality of their location decisions with solicited community input. For example, my colleague Rex Honey and our students in the geography department at Iowa utilized computer-interactive spatial analyses for conveying both past and projected spatial demographics to decision-makers in the field of public education. The contexts were school enrollment projections for Iowa schools, the location of new schools or the closure of old schools, and the spatial reorganization of the administration of school districts.

We used a more efficient heuristic for solving large p-median problems [9] and kernel ratio-estimation functions [10] for calculating spatially-varying rates of student

enrollment growth or decline. After geocoding individual student data, enrollment changes over flexibly-defined geographic catchment areas were monitored for projecting future enrollments for small areas and providing spatial decision support for the public where conflicts occurred; see also Tom Eagle's chapter [11]. These efforts continued with applications in legislative redistricting in South Africa [12].

1.5 Health Geography 1996-2002: Geographic Information Systems and Public Health

I renewed my primary research interest in Health Geography after I realized the field of public health had many substantive problems for which GIS methods and tools were useful (e.g., [13]; see also chapters by Ellen Cromley [14], and Sara McLafferty, Avijit Ghosh and Jamie Fishman [15]). I had answered a call from a university colleague in Pediatrics who asked whether it was true that State Department of Health records could be automatically mapped and made available to the press. My colleague was concerned about a journalist's report in The Des Moines Register of hotspots in one area of Des Moines, IA, with high rates of death from congenital diseases allegedly caused by pollution levels in surrounding areas.

Following some publications in this field as well as some committee assignments with public health groups, I subsequently received a grant with colleague Marc Armstrong from the U.S. Department of Education to develop modules to educate the public health workforce in the use of GIS in public health research and practice. Together with Bob Aangeenbrug and others, I was invited by the National Cancer Institute (NCI) to advise it about implementing the Long Island Breast Cancer Project.

1.6 Health Geography 2003-present: Geocoding Cancer Data and Mapping Small Area Incidence, Mortality, and Staging Cancer Patterns

Another theme in my renewed research in Health Geography was the refinement of kernel density methods to display spatial patterns of cancer using typical disease registry data. This research developed after serving on a committee of the NCI charged with developing a plan for cancer surveillance for the millennial decade. My students and I embraced the recommendation for cancer data to be routinely geocoded to a fine geographical level for mapping small-area cancer rates [16].

Recent research has focused on principles for mapping chronic diseases, such as cancer; see also Kirsten Beyer's chapter [17]. My innovation has been that, instead of starting the disease mapping process with a traditional data matrix with areas in the rows and rates of disease in the columns, the process begins with very small area data and then aggregates information for areas with approximately the same size populations at risk. The disease rate estimates consequently have approximately constant variability in errors of estimate. This spatial aggregation estimate therefore relieves a map from its principal failure in the contemporary literature of having estimates of disease rates with different levels of statistical error across the map.

1.7 The Present and Future

My crossing the Atlantic Ocean for five days on The Queen Mary, and taking the train from New York City to Iowa City in September, 1961, changed my life in so many ways. I often think of Harold "Mac" McCarty who welcomed me to the University of Iowa as a Fulbright Scholar from the

University of Wales in Aberystwyth. Mac inculcated the spirit of scientific scholarship among faculty and students at the university at a time when so little of the scholarship in geography was done in this spirit.

My plan was to stay one year in America, but that year grew to two more years as a graduate student at the University of Iowa; three years as an assistant professor at McMaster University, Canada; two years at Michigan State University; and a return to Iowa that lasted 45 years with a two-year interim at San Diego State University.

I now have joined the ranks of Professor Emeritus and, after three years of feeling my way to a different daily routine, I am beginning to find the rewards of this new life. I still check the week's schedule ahead but there are far fewer items on it. The academic literature continues and I continue to follow and enjoy much of it. I retired with four unfinished student dissertations in progress. The number is now two. That, too, is part of my present workload. I also have a weekly phone call with two former students and I am currently enjoying finishing our second paper for publication since retirement. I accept most invitations to review the scholarship of others for their periodic professional evaluations. Taking most of my time for continued professional work are the services I do on several National Institute of Health (NIH) review groups.

I smiled recently after receiving an e-mail from NIH, stating that since I had served on at least six research proposal review groups in the past eighteen months, I am now allowed to submit proposals to many of their research solicitations at any time rather than follow their deadlines for bi-annual submissions! These reviews each take at least one week of work and frequently a day or two in Washington, DC. But I enjoy the challenge of evaluating proposals for research and discussing them with multi-disciplinary review groups.

So, as I now watch from a distance the University of Iowa's Geography Department, I support and pay some attention to the Gerard Rushton Academic Excellence Fund, and I thank the Geography Alumni for their generous gift that set up this fund. I hope that it will contribute to a never-ending effort to enrich the discipline through the work of faculty and students while helping to maintain a community of excellence on the prairie.

Farther afield, Carolyn and I acquired a vacation home with swimming pool in Punta Gorda, FL, shortly after my retirement. After installing a solar heater for the pool, I enjoy at least two swims a day with water temperature never below 80 degrees F at any time of year. It has beautiful sunset views of "the Meadows" and, especially in summer, it is nice to swim under the stars. Both our sons and their families visit there at least twice a year and our five-year-old granddaughter says, "I'm going to live in Florida when I grow up!"

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