

TOWARD SPATIALLY INTEGRATED SOCIAL SCIENCE

MICHAEL F. GOODCHILD

*Department of Geography, University of California, Santa Barbara,
good@ncgia.ucsb.edu*

LUC ANSELIN

*Department of Agricultural and Consumer Economics,
University of Illinois at Urbana–Champaign,
anselin@uiuc.edu*

RICHARD P. APPELBAUM

*Department of Sociology, University of California, Santa Barbara,
appelbau@alishaw.sscf.ucsb.edu*

BARBARA HERR HARTHORN

*Department of Anthropology, University of California, Santa Barbara,
bharthor@omni.ucsb.edu*

This article outlines the motivation for a spatial approach as a novel focus for cross-disciplinary interaction and research in the social and behavioral sciences. The authors review the emerging interest in space and place in the recent social science literature and develop a vision for a spatially integrated social science. This vision provides the conceptual basis for a program of six activities designed to promote a spatial perspective: learning resources, workshops, best-practice examples, place-based search, software tools, and a virtual community. The six programs will be informed by advances in the methods, technologies, and principles underlying spatial information science.

The analysis of space and place has become an increasingly pivotal component of social science research in the past two decades. In part, this can be attributed to the transformation of social space around the globe, accompanied by shifts of varying degrees of magnitude in social science conceptualizing and theorizing. One aspect of these changes is subsumed under the general notion of “space-time compres-

This article is a revised and shortened version of a proposal to the U.S. National Science Foundation (NSF) titled “SPeSS: A Center for Spatially Enabled Social Science,” which resulted in a five-year award to the University of California, Santa Barbara. Earlier versions were presented at the Interuniversity Consortium for Political and Social Research Meeting of Official Representatives on “Approaching

sion” and results largely from such revolutions in information and communication technology as the microchip, satellite television, and low-cost, high-volume transoceanic shipping and travel. Other rapid transformations result from huge shifts in populations across the globe through migrations of unparalleled scope and scale. Also of note are the changing political landscapes of the late twentieth century with their kaleidoscope effects of expanded (e.g., the European Community) or contracted (e.g., former Soviet Union states) territorial boundaries. All of these changes in the space and place of peoples and nations have profoundly affected the spatial organization of the social, the economic, the political, and the cultural—the key domains of focus of the social sciences.

The centrality of space and place has always been taken for granted in geography and regional science. In contrast, in the mainstream of the social sciences, attention to the spatial (and space-time) dimension of phenomena is much less apparent, although a recent revival of sorts is occurring. For example, a growing number of social scientists have taken up the use of the sophisticated technology and new methodologies of spatial analysis (such as geographic information systems, global positioning system [GPS], remote sensing, and spatial statistics) in their empirical work. In addition, increased attention is paid to location and spatial interaction in theoretical frameworks. However, much remains to be done before a full integration of the spatial perspective in both theory and methodology of social science can be achieved.

In this article, we outline the motivation, vision, and organizational framework for the development of a research infrastructure to enhance the ability of social and behavioral scientists to adopt a spatial approach. We argue that a concerted effort to advance and disseminate geographic tools and concepts—spatial analysis, geographic information systems, geolibraries—as integrating themes that cut across the traditional disciplinary boundaries of the social sciences will work toward the development of a more spatially oriented vision in future social science research. These efforts will be implemented as part of a five-year social science research infrastructure project funded by the U.S. National Science Foundation and established at the University of California, Santa Barbara.

In the remainder of the article, we first elaborate on our motivation for focusing on spatial analysis as an integrating force for the social sciences. This is followed by the main part of the article, a selective review of recent examples in which the importance of space and place was recognized and incorporated in social science

the Millennium: New Paradigms for Social Science Research,” Ann Arbor, Michigan, 14-17 October 1999, and at a special session in memory of William Alonso at the 46th North American Meetings of the Regional Science Association International, Montreal, Canada, 11-14 November 1999. We appreciate the constructive comments and suggestions received from a large number of people, including Helen Couclelis, Terence Smith, Stuart Sweeney, Bruce Newbold, Sergio Rey, and anonymous reviewers. This article was supported in part by NSF Grant No. BCS-9978058 to the Center for Spatially Integrated Social Science.

research. Next, we outline our vision for spatially integrated social science. We also briefly describe the main features of the six major infrastructure programs. We close with a call for participation to the research community at large.

MOTIVATION

During the past decade, a major effort to advance the state of the art and address important research issues in geographic information science was carried out through the programs of the National Center for Geographic Information and Analysis and the Varenus Project (Abler 1989; National Center for Geographic Information and Analysis 1999; Goodchild et al. 1999). We build on the repositories of knowledge and skills from this experience to argue that a systematic program for extending the analytic power of sophisticated spatial analysis to the social sciences would return immense long-term benefits in the form of scientific progress.

A number of factors suggest the growing importance of spatial information and the need for techniques to manipulate this information. Enormous advances in the power of information technologies have gone hand in hand with an increase in the availability of geocoded data (data that include the location of the phenomenon measured). Modern geographic information systems (GIS) have simplified the collection, handling, and analysis of spatial data (Longley et al. 1999). It is now comparatively straightforward to sift through large amounts of social data looking for patterns and anomalies, leading to the development of new and interesting hypotheses. The term *exploratory spatial data analysis* (Anselin 1999b) encompasses a range of novel ideas for inductive examination of data from a spatial perspective, allowing pattern recognition and spatial data mining. From a deductive viewpoint, the statistical analysis of spatial data is characterized by a tendency for such data to violate the standard assumptions of statistics, notably independence and stationarity. Recently, methods for handling these problems have advanced dramatically, through the development of spatial regression, spatially weighted regression, and related methods of spatial statistics, and these methods are now suitable for widespread dissemination and use by social scientists (Anselin 1988, 2000b; Cressie 1993).

From a theoretical perspective, there is a resurgence of interest in the explicit inclusion of space in the theory of several social science disciplines (Anselin 1999a). To some extent, these endeavors are characterized by a paradigmatic shift. For example, rather than assume a single, homogeneous population of agents with uniformly perfect information, there is increasing interest in economic models of spatially dispersed and heterogeneous populations with imperfect communication (e.g., Durlauf 1997; Akerlof 1997). More and more scientific attention is being directed to systems consisting of large numbers of interacting agents with complex behaviors. The goals of this work are not always the traditional ones of discovery of simple, general principles, since it is considered unlikely that such principles will

emerge given the degree of complexity in the system. Rather, such systems provide norms for comparison with real behavior, and differences between model and reality provide the basis for improvement in our understanding of the general principles programmed into the models (Arthur, Durlauf, and Lane 1997). A formal treatment of location, spatial interaction, and space-time dynamics is central to these efforts.

Finally, space provides the framework for the integration of different social processes and, hence, different domains of social science. Reductionist traditions in science have led to our current arrangements in which different classes of processes are studied largely in isolation, in distinct disciplines, and often without specific attention to space and time. In the real world, these separate processes interact in a spatiotemporal context. New tools and data sources now allow treatment of the more general case. Also, although basic science is directed at the discovery of general principles, the ultimate value of such knowledge, apart from simple curiosity, lies in our ability to apply it to local conditions and, thus, determine specific outcomes. Although such science may itself be placeless, the application of scientific knowledge in policy inevitably requires explicit attention to spatial variation, particularly when the basis of policy is local.

We argue therefore that a spatial approach provides a compelling basis for integration between the sciences and elaborate on its specific role within the social sciences in the next section.

IMPORTANCE OF SPACE AND PLACE IN THE SOCIAL SCIENCES

The study of space cuts across a broad range of social science disciplines, raising fundamental questions about the location of human activities, the construction of social space, and the relationship between social space and physical environment. Below, we list some illustrative examples of areas of study in which thinking spatially and the application of spatial analysis have changed the way social scientists approach scientific problems. We believe that this has created a demand for increasingly sophisticated methodological tools and conceptual frameworks that explicitly incorporate the role of space.

We do not intend to be comprehensive; rather, we provide a sampling of a vast literature that spans the social and behavioral sciences and their relation with many other disciplines. Specifically, we illustrate a number of cases in which cross-disciplinary approaches are applied to social issues where place and space play a crucial role. In part, we review the literature, but we also suggest some areas in which a more explicit spatial approach would be promising. Before discussing specific applications, we briefly sketch some exciting new developments related to the growing acceptance of spatial approaches in the mainstream of economics, sociology, and political science.

SPACE IN THE MAINSTREAM

Perhaps the most visible recent example of the increasingly prominent role of space and place in the mainstream of social sciences is provided by the new economic geography as embodied in the work of Krugman (1991a, 1991b, 1996), Arthur (1989), Glaeser et al. (1992), and other economists.¹ Arguably, this work is an extension and transformation of Isard's (1956) original location and space economy, which lay at the basis of regional science, but uses modern tools of mathematical analysis (Fujita, Krugman, and Venables 1999). Central to the new economic geography is an explicit accounting for location and movement in theories of trade and economic development. The resulting models of increasing returns, path dependence, and imperfect competition induce various forms of spatial externalities, agglomeration economies, and spillovers, whose spatial imprint requires a spatial econometric approach in empirical work (e.g., Anselin 2000a; Ioannides 2000). A similar development has occurred in sociology, where a recent renewed attention to the ecological perspective pioneered by the Chicago School in the 1920s has yielded a growing number of studies in which computerized mapping and spatial analysis techniques have become central (Abbot 1997). These efforts follow directly from theoretical frameworks that relate individual behavior to that of a geographical "context" in empirical investigations of social capital, sense of community, and neighborhood effects (Morenoff and Sampson 1997; Sampson, Morenoff, and Earls 2000). In political science as well, especially in the study of international relations, a spatial perspective is increasingly prominent in theoretical as well as empirical approaches, suggesting the formation of a new geopolitics (Starr 1991; Ward 1992; O'Loughlin et al. 1999).

URBAN STUDIES

Urban sociologists, geographers, and economists theorize that the economic role of cities is changing in light of their increased ease of access to distant economic activities. For example, cities and regions are now seen increasingly in terms of their role in global financial transactions (Sassen 1993, 1994, 1996), industrial production chains (Gereffi 1994, 1997; Appelbaum, Smith, and Christerson 1993), evolving trading structures (Ioannides 1997), and interacting networks (Glaeser et al. 1992; Krugman 1991a, 1991b, 1996), leading to new conceptualizations about hierarchies of place that are tied to global as well as regional geographies. At the same time, there is renewed interest in the importance of purely social interactions that contribute to strong regional economies and unique institutions and cultures (Akerlof 1997; Arnold and Appelbaum 1995; Borjas 1995; Glaeser, Sacerdote, and Scheinkman 1996; Logan and Molotch 1987; Soja 1997; Scott and Soja 1998; Storper and Walker 1989). Such interactions are often seen as purely

economic in nature—the role of face-to-face interactions in reducing business transaction costs. But the symbolic meaning of location can also have economic effects, as is evidenced by the concentration in Los Angeles of industries that benefit from the cultural significance of that location (Molotch 1995). GIS analyses have already been used to examine the relationship between ethnicity, space, and the location of production in Los Angeles's apparel industry (Bonacich and Appelbaum 2000). In addition, the empirical validation of many of the new theoretical constructs related to interacting agents require the explicit account of space, location, and spatial interaction that can be provided by the methodology of spatial statistics and spatial econometrics.

BUSINESS AND SOCIAL NETWORKS

Social networks in general are fundamentally conceptualized in terms of spatial disaggregation, and many social scientists are analyzing the spatial aspects of networks—for example, in tracking transnational migration (Kearney 1995) or identifying high-risk populations (Brown et al. 1998). Paralleling the work on social networks is the recent attention in economics to interacting agents and related notions of strategic interaction. This demands an explicit account for spatial interaction and spatial dependence in empirical models, requiring sophisticated spatial econometric methods, many of which have yet to be developed (e.g., Besley and Case 1995; Brueckner 1998; Case, Rosen, and Hines 1993; Murdoch, Sandler, and Sargent 1997). Business networks are also a focus of extensive spatial analysis. In many industrial firms, particularly those that depend on large retailers to market their products, an increasingly broad range of economic activities that were once performed by a single firm are now outsourced to independent contractors. Manufacturers of diverse products, ranging from apparel to consumer electronics, frequently depend on independent suppliers for components and even final assembly. The resulting business networks can become organizationally complex, with significant national differences in preferred modes of coordination (Gerlach 1992; Hamilton and Feenstra 1997; Hamilton and Kao 1990; Orrú, Biggart, and Hamilton 1997; Whitely 1992, 1996). There are a number of databases that track nationally based trade (import-export) statistics over time, and a few that look at internal transactions between business groups for specific countries. Very little is presently understood about the mediating role of space in these arrangements, apart from some explorations of spatial patterns and fairly crude estimates concerning the costs of conducting transactions over distance (Aten 1997; Christerson 1994; Appelbaum and Christerson 1997; Christerson and Appelbaum 1995). A more explicit spatial perspective, exploratory as well as confirmatory, would permit considerable refinement of these estimates.

SOCIAL AND ECONOMIC INEQUALITY

The spatial distribution of inequality has long been of interest to anthropologists, sociologists, and political scientists (e.g., Harvey 1996). The existence of regional and intraurban concentrations of poverty, frequently alongside wealth-generating activities, lends itself to spatial analysis. For example, it has been argued that cities such as New York, London, and Tokyo not only serve as global financial centers and corporate headquarters, but for that very reason also create spatial concentrations of minority (and often largely immigrant) populations that provide the necessary supportive services (Sassen 1993, 1994). To take another example, one of the most controversial recent issues in U.S. race and ethnic studies is whether multigenerational poverty among blacks and Hispanics can be partly explained by their spatial concentration in urban hyperghettos, from which both job opportunities and middle-class role models have fled (Wilson 1987, 1997). Similar concerns pertain to the convergence debate in economic geography, that is, the extent to which regional incomes diverge or converge. The study of spatial distributions of wealth and poverty, including their persistence over time, can clearly benefit from recent advances in spatial analysis, as illustrated in Fingleton (1999) and Rey and Montouri (1999).

ENVIRONMENTAL AND CLIMATE CHANGE

Remote sensing, GIS, and spatial econometrics have already been used effectively to analyze the relationship between human activities and local environmental change, in particular in the area of deforestation and changing patterns of land use (Chomitz and Gray 1995; Moran and Brondizio 1998; Nelson and Hellerstein 1997; Wood and Skole 1998). Indeed, the entire issue of environmental sustainability has a crucial spatial dimension that researchers across the social sciences are addressing substantively, methodologically, and theoretically (e.g., Bockstael 1996; Bray 1998; Escobar 1995; Stonich 1998b). On the most material level, archaeologists have been at the forefront of social scientists incorporating sophisticated methods of spatial analysis, for example, using sophisticated spatial analysis to model and compare prehistoric and contemporary archeological and social phenomena in the Petén, Guatemala (Sever 1998). However, beyond the material aspects of human life, the analysis has been far more limited. The relationship between human activities and global climate change remains only partially articulated. Earth system scientists have developed powerful models that explain and predict such change on a purely physical basis—for example, the National Center for Atmospheric Research's Climate System Model, which models complex interactions of all aspects of the climate system: atmosphere, ocean, cryosphere, hydrosphere, biosphere, terrestrial ecosystems, and land surface processes. Such models

have yet to account adequately for regional climate change variations that are due to human effects, such as regional differences in population growth, migration, industrialization, and urbanization. Some human impacts are relatively localized; others may aggregate into more global changes. The reciprocal relationship between socioeconomic change and physical change requires the integration of socioeconomic data into existing physical climate change models, with special attention to spatial as well as aggregation effects. Social scientists have begun to work with earth system scientists to address these issues (Berk 1992a, 1992b; Kolstad 1998); spatial analysis will play a central role in their efforts.

HEALTH AND DISEASE

Research using remote sensing, GPS, and GIS has examined the cross-regional flows of disease microbes and their relationship to changing patterns of environmental disturbance, landscape characteristics, and more general global climate change (Epstein 1998; Kitron 1998). Public health in the United States is necessarily concerned with spatial aspects of environmental pollution, the spread and control of infectious diseases, and the delivery of critical health care and social services. The Centers for Disease Control, for example, are a leading user of spatial analysis in epidemiological studies to help in the formulation of policy and the distribution of services, and this approach is now being replicated on many levels within the public health system (Gatrell and Loytonen 1998; Walsh, Page, and Gesler 1997). Mapping of disease risk is increasingly subjected to sophisticated spatial modeling and statistical analyses (Lawson et al. 1999). Sociologists, economists, anthropologists, and others in the environmental justice movement have extended these analyses outside the realm of public health services to examine the spatial relationship between toxic waste facilities and other environmental contaminants and the distribution of low-income or minority populations (Bullard 1994; Collin and Harris 1993; Lee 1993; Szasz 1994). Spatial inequalities in access to health care have also been researched (Harthorn 1998; Reagan 1998). This interest adds to the growing number of demographic studies in which an explicit role is given to location and spatial interaction—for example, in studies of fertility (Tolnay 1995) and contraceptive choice (Entwisle et al. 1997).

CRIMINAL JUSTICE

The causes of criminal activities are much debated by criminologists, sociologists, and economists (e.g., DeFronzo and Hannon 1998; Kposowa and Breault 1993; Land, McCall, and Cohen 1990). Crimes such as theft and burglary, as well as most categories of violent crimes, are more likely to be found in low-income urban areas that have relatively high proportions of unemployed persons and racial minorities (U.S. Bureau of Justice Statistics 1997). In addition, law enforcement efforts (Chambliss 1994), gang activity (Cohen et al. 1998), and perception of

crime (DeFrances and Smith 1996) also vary spatially, suggesting the need for an explicit spatial perspective (Roncek 1993). Currently, the Federal Bureau of Investigation's *Uniform Crime Reports*, as well as the Bureau of Justice Statistics' semi-annual *National Crime Victimization Surveys*, reports large-scale spatial differences for different categories of crime (e.g., urban, suburban, rural), findings that have prompted a search for spatial mechanisms such as proximity and diffusion to explain these phenomena (Messner et al. 1999; Morenoff and Sampson 1997; Tolnay, Deane, and Beck 1996). In addition, crime analysts increasingly use GIS and spatial analysis tools in the investigation of hot spots and other crime patterns and design intervention mechanisms with the use of spatial decision support systems (Block and Block 1995; Block 1998; Anselin et al. 2000). Because crime and enforcement data are commonly geocoded, social scientists can now engage in fine-grained studies of patterns and underlying causes, which drives the demand for ever more sophisticated methods of spatial analysis.

SYMBOLIC MEANING OF SPACE

Anthropologists, sociologists, political scientists, and legal scholars examine the ways in which symbolic space serves to structure and culture social activities. For example, the study of religious and ethnic nationalism, which is on the rise throughout the world today (Beyer 1994; Juergensmeyer 1993, 1995), places special emphasis on the importance of symbolic space and imagined communities (Anderson 1983). Special meanings are attributed to physical locations, ranging from sites with special religious or historical meaning to entire national or transnational territories (Darian-Smith 1999; Friedland and Hecht 1996; Hancock 1999). Often, this can result in the emergence of politics constructed around and through place-based identities (Keith and Pile 1993). Although the symbolic meaning of space is frequently theorized in this cultural research, it is seldom subjected to forms of spatial analysis that might suggest uniformities across different times and places or more detailed specificities in patterns and arrays. A rich research agenda remains to be investigated.

COMMUNITY STUDIES

It is one of the paradoxes of the late twentieth century that at the same time global forces create more interconnections between peoples, the interest in the local has exploded. As a reflection of this interest, many social scientists are engaged in community-based research with a significant if not overriding spatial concern. For example, GIS-trained anthropologists have examined the transnational interconnections (e.g., over the Internet) of grassroots and community organizations in Latin America, South and Southeast Asia, and Africa in forming resistance to the global shrimp mariculture industry (Stonich 1998a). Sociologists at the University of Chicago use GIS and spatial analysis in studies that attempt to capture the spatial

structure of the notion of social capital (Sampson, Morenoff, and Earls 2000). In women's studies, social scientists have become increasingly interested in closely examining the local cartographies of struggle for women in the developing world (Mohanty, Russo, and Torres 1991; Shiva 1989). On a more technical level, public participation GIS researchers have begun to examine the social and political effects of the dissemination of GIS technologies at the community level and have started to explore multiple ways in which community input and perception can be integrated into the tools of spatial analysis (Craig and Elwood 1998; Elwood and Leitner 1998; Harris and Weiner 1998; Talen 1999, 2000).

A VISION FOR SPATIALLY INTEGRATED SOCIAL SCIENCE

The range of interest in and potential for the application of a spatial perspective in the social sciences, reported on in the previous section, provides a tremendous opportunity to gain new scientific insights through the application of sophisticated tools of spatial analysis. We refer to this leveraging and enabling property as the development of spatially integrated social science. In this context, we use the term *spatial* as shorthand for *spatiotemporal* to refer to data and phenomena with both spatial and temporal dimensions of variation, since most research questions of interest to social and behavioral scientists will be dynamic in nature.

Similar to the way in which a collection of common theories and methods is shared by cross-disciplines such as quantitative social science, or qualitative analysis, we outline the types of concepts, techniques, and tools that we believe should be part of a spatially integrated social science. Specifically, we see such science including an exposure to, a familiarity with, or an access to a number of aspects pertaining to different components of spatial analysis.

Representation of spatial phenomena. This would include concepts behind the methods commonly associated with GIS such as raster and vector representations, issues of scale and accuracy, concepts of location, and concepts of spatial relationships.

Spatial data analysis. Principles of statistics in a spatial context are contained in spatial statistics, geostatistics, and spatial econometrics and based on the concept of a spatial random field. They incorporate models of spatial dependence and spatial heterogeneity, allowing for specification testing, estimation, and prediction of spatial phenomena observed as points, continuous surfaces, or lattices (regions). Spatial data analysis tools therefore permit exploration of data from a spatial perspective, looking for spatial patterns, correlations, outliers, and residuals and submitting

apparent patterns to rigorous statistical tests. They also permit the confirmatory testing of nonspatial hypotheses using spatial data.

Visualization and communication of spatial information. This includes the concepts behind and tools for cartography and dynamic visualization, which make it possible for complex, multidimensional data to be communicated visually and for the human visual system to use its full powers of visual pattern recognition and inference.

Simulation of social systems in a spatial and temporal context. Such simulation models and software are built on an explicit treatment of location and interaction, allowing for sophisticated representations of space-time dynamics. This has applications to models of the spatial aspects of future urban growth, spatial behavior of individual economic agents, redistribution of global capital and industrial activity, and so on.

Access to spatial data. Sophisticated methods exist that implement a place-based search, including search of Internet information resources based on place. Studies of spatial variation, or studies with a local focus, would be enormously facilitated by better means for searching distributed archives for information about specific geographic locations.

Best-practice examples. For the leveraging argument of spatial analysis to be most powerful, spatially integrated social science should refer to a common body of examples of advances in social and behavioral sciences that resulted from the use of a spatial perspective. Much powerful cross-fertilization could occur between the sciences if there were better access to exemplary studies that use spatial perspectives.

PROGRAMS

Our vision for a spatially integrated social science provides the conceptual basis for a program of six activities: learning resources, workshops, best-practice examples, place-based search, software tools, and a virtual community. These programs will be informed by advances in the methods, technologies, and principles underlying spatial information science. They are designed to provide an infrastructure that widens the appeal and facilitates the dissemination of the spatial perspective. It does not constitute a research program per se; instead, the program is a collection of initiatives to support research across a range of disciplines, taking advantage of the latest in Web-based technology.

Although a full description of each program is beyond the scope of this article, we will summarize the main motivation and basic features for each of the six activities.²

LEARNING RESOURCES

A significant impediment to the growth of a new approach to science is a lack of textbooks and other materials for starting courses, or for including new material in existing courses. Publishers are reluctant to encourage the writing of textbooks until a market is seen to exist, and instructors are often hesitant to introduce new material without access to good resources. At this time, very few textbooks are available to support learning in spatially integrated social science, and none takes a comprehensive approach consistent with the vision outlined above. In contrast, the World Wide Web is an excellent medium for dissemination of materials in support of learning, and its use in areas relevant to spatially integrated social science has been demonstrated repeatedly.³

A collection of Web-based learning resources will be developed to assist instructors in assembling materials for courses by providing supporting notes, illustrations, examples, lab materials, references to the relevant literature, exam and discussion questions, and links to related material and other Web resources. They will leave most pedagogic issues to the instructor, focusing instead on providing content in new areas where conventional sources are not yet adequate. The collection will be placed in the public domain and disseminated from a central Web server.

WORKSHOPS

The second strategy for inducing systemic change in the social and behavioral sciences is based on a series of intensive workshops, geared primarily to an audience of junior faculty and graduate students, but some will also be aimed at methodological “leaders” in various social science disciplines. In today’s academic world, there are relatively few opportunities for sustained interaction and learning in residential settings; yet, such interactions are extremely valuable in stimulating interest and in building working relationships and collaborations. They can also be effective ways of leveraging limited resources if participants undertake to promote workshop ideas when they return home, through new courses, application of tools obtained at the workshop, or introduction of a spatial perspective in their own research.

The workshops will be loosely based on the model successfully implemented for several years at the ICPSR Summer Program in Quantitative Methods, but rather than being centralized on one campus, they will be decentralized, using instructors and appealing to audiences at different universities. The workshops will draw on a set of instructional materials (including tools and best-practice examples) dealing with topics ranging from exploratory spatial data analysis to spatial econometrics, spatial interaction theory, agent-based spatial modeling, GIS, place-based search,

spatial data modeling, and explicit spatial theory. The different teaching settings will allow for some variation in personal style and approach. Teaching materials also will be made available on the World Wide Web and integrated with the Learning Resources program, and become an intrinsic part of the Virtual Community program.

BEST-PRACTICE EXAMPLES

The third strategy for building a collaborative, spatially integrated social science focuses on the development of a series of examples of best practice and their widespread dissemination. The motivation for this program is that a collection of cases in which demonstrable and compelling new insights are gained using a spatial approach to a research question will go a long way to convince “mainstream” scientists of the value of spatial thinking. These examples will be compiled from an annual open competition that will provide funding for the development and documentation of successful proposals, ranging from inductive, data-driven exploratory research that leads to new theory to deductive, theory-driven research that advances our understanding through empirical tests. Examples could include use of spatial analysis, modeling and simulation in spatial context, addition of space to theory, explicit treatment of space in policy, or spatial decision support (or any combination of these). A mechanism will be put in place to call for proposals, select successful ones, and disseminate the findings, again based on the use of Web technology.

PLACE-BASED SEARCH

The World Wide Web has been enormously successful at providing access to a range of information and facilitating its widespread and rapid dissemination. The Web has been compared to a library, and indeed the total amount of information accessible via the Web already greatly exceeds the amount accessible in any of our major research libraries. Although the Web is powerful in many respects, it still remains far inferior to libraries in its lack of quality control and assurance (the Web equivalent of the publisher’s peer review and the collection-building services of libraries) and of comprehensive abstracting and cataloging. The major search engines provide primitive machine-generated catalogs but are limited by their almost exclusive focus on textual information and by their crude mechanisms for selecting key words.

A spatially integrated social science will require mechanisms for finding information about places, or place-based search, that pertains to information that is geo-referenced. Place-based search supports the finding of information based on a defined footprint, specified either in geographic coordinates or by reference to one or more place names. Many efforts are currently under way to develop support for place-based search, but none is specifically targeted to the unique problems of the social and behavioral sciences.⁴

The fourth strategy in our program consists of a series of facilities to carry out place-based search. This includes a Web site pointing to sources of information, the implementation of mechanisms to search based on space in major digital catalogs, and the development of a unified gazetteer for the social and behavioral sciences. The gazetteer provides the means to link place names to geographic coordinates. It will include place names and reporting zones used in major information sources such as the census, together with the means to integrate data based on different geographic zones. This will be implemented in collaboration with major repositories of social and behavioral data, such as ICPSR.

SOFTWARE TOOLS

Tools to enable a spatial approach to social science have emerged rapidly in the past decade, and a flourishing software industry is now supported in part by social science applications. The tools include GIS, statistical packages with substantial spatial or geostatistical functionality, simpler packages for mapping, specialized software for transportation analysis, and packages to support data collection in the field. In general, these tools tend to be either specialized and sophisticated with a steep learning curve or commercial off-the-shelf products that are user friendly but not powerful enough to satisfy the demands of the academic market. We believe that a spatially integrated social science will require a new kind of tool, capable of powerful analysis but comparatively accessible, extensible, and user friendly.

The fifth strategy in our program consists of building a next-generation set of tools for spatial data analysis based loosely on the software package known as SpaceStat (Anselin 1992). Development will focus on three major areas. First, the existing functionality for exploratory spatial data analysis will be extended and tightly integrated with the data models of a GIS. The new tools will allow data to be explored simultaneously from several different perspectives or at several different levels of spatial aggregation. This set of tools consists of a refinement of the existing SpaceStat-ArcView interface (Anselin and Bao 1997). The second area consists of a suite of modular software components to carry out spatial statistical and spatial econometric analyses. These components could be used either in combination with a user interface or independently by researchers who want to incorporate them into their own specialized applications. The third area deals with the development of software for advanced spatial econometric techniques dealing with panel data and categorical variables.

VIRTUAL COMMUNITY

The final strategy is to build a community of spatially integrated social scientists by means of the tools of the Internet in the form of a virtual community. The physical implementation consists of a central Web site that offers access to the products and activities of the full range of other programs. In addition, it will be a clearing-

house for information about other activities nationally and internationally that are likely to be of interest to the community. Important aspects of the virtual community will be an advice hotline and push services to individual users who select particular types of information.

In addition to these Web-based services, a second important component of the virtual community is to become a focus for sharing software objects for spatially integrated social science. The protocols and standards underlying the software tools will be made available to encourage others to contribute tools consistent with these. In the past, this model has worked extremely well in building an active software-sharing community around such nuclei as GRASS (a GIS originally developed by the Army Corps of Engineers in the 1980s) and the Linux operating system.

CONCLUSION

“If you build it, will they come?” As one reviewer aptly put it, the premise underlying our argument is that an infrastructure to facilitate and promote spatial thinking in the social sciences will indeed be used by social scientists. The review of existing studies in which space and place are given an important role is very encouraging in this respect. Three common threads can be extracted from this review. First, the demand for spatial analysis is stimulated as much by the technical factors (the existing technology for spatial data handling and the large volume of geocoded data) as by theoretical questions raised in the substantive fields of the social sciences. Consequently, we can assume that this is a genuine need that indeed is driven by the mainstream disciplines. Second, scientific research is increasingly interdisciplinary and cross-disciplinary, and the demand for advanced techniques is derived from substantive research questions that follow from the cross-fertilization between disciplines. In other words, these are not techniques in search of an application but, rather, methods required to tackle critical modeling issues that are part of novel conceptual frameworks. Third, in light of the lack of an easily accessible clearinghouse and support system for the application of advanced spatial analysis in the social sciences, there is a worrisome tendency for scholars to “reinvent the wheel.” Not only is this a waste of some thirty years of insights gained in regional science, analytical geography, and spatial statistics, it is likely that the mistakes of the past will simply be repeated, slowing down scientific progress rather than advancing it.

A crucial ingredient for the success of an endeavor such as the one outlined in this article is the participation of the scholarly community. This participation takes many forms: input in the prioritization and selection of learning materials, workshop content, and software tools; participation in developing best-practice materials; and interest in dissemination and interaction through the virtual community. A number of mechanisms will be developed to invite such participation by taking advantage of new Web-based technologies.

We hope that our argument for spatially integrated social science and the ensuing support infrastructure will provide a stimulus for advancements in scientific knowledge. We are well aware that not all social science is spatial but suggest that even in nonspatial areas of inquiry an increased awareness of the concepts and tools of spatial analysis may lead to novel insights. However, our main argument pertains to the wide range of research questions where location and spatial (space-time) interaction is increasingly incorporated explicitly and where the provision of a support system for spatially integrated social science is likely to yield significant leverage.

NOTES

1. Recent reviews can be found in Martin (1999) and in a collection of essays on *Is Geography Destiny?* published in a recent issue of the *International Regional Science Review* (David 1999; Krugman 1999; Rauch 1999; Gallup, Sachs, and Mellinger 1999; Henderson 1999; Venables 1999).
2. A complete description of the programs can be found in the original proposal to the National Science Foundation, available at <http://www.ncgia.ucsb.edu>.
3. For example, see the Virtual Geography Department project, <http://www.utexas.edu/depts/grg/virtdept/main.html>, or the National Center for Geographic Information and Analysis core curriculum in GIScience, <http://www.ncgia.ucsb.edu:80/education/curricula/gisccl/>.
4. Examples are the U.S. Environmental Protection Agency, which provides facilities to search for information by zip code (http://www.epa.gov/enviro/zipcode_js.htm) and the Alexandria Digital Library for maps and images (<http://www.alexandria.ucsb.edu>).

REFERENCES

- Abbot, A. 1997. Of time and space: The contemporary relevance of the Chicago School. *Social Forces* 75: 1149-82.
- Abler, R. F. 1989. The National Science Foundation National Center for Geographic Information and Analysis. *International Journal of Geographical Information Systems* 1: 303-26.
- Akerlof, G. A. 1997. Social distance and social decisions. *Econometrica* 65: 1005-27.
- Anderson, B. 1983. *Imagined communities: Reflections on the origin and spread of nationalism*. London: Verso.
- Anselin, L. 1988. *Spatial econometrics: Methods and models*. Boston: Kluwer Academic.
- . 1992. *SpaceStat, a software package for the analysis of spatial data*. Santa Barbara, CA: National Center for Geographic Information and Analysis.
- . 1999a. The future of spatial analysis in the social sciences. *Geographic Information Sciences* 5.
- . 1999b. Interactive techniques and exploratory spatial data analysis. In *Geographical information systems*, 2d ed., edited by P. A. Longley, M. F. Goodchild, D. J. Maguire, and D. W. Rhind. New York: Wiley.
- . 2000a. GIS, spatial econometrics and social science research. *Journal of Geographical Systems* 2.
- . 2000b. Spatial econometrics. In *Companion to econometrics*, edited by B. Baltagi. Oxford: Basil Blackwell.
- Anselin, L., and S. Bao. 1997. Exploratory spatial data analysis linking SpaceStat and ArcView. In *Recent developments in spatial analysis*, edited by M. Fischer and A. Getis. Berlin: Springer-Verlag.

- Anselin, L., J. Cohen, D. Cook, W. Gorr, and G. Tita. 2000. Spatial analyses of crime. In *Criminal justice 2000: Volume 4. Measurement and analysis of crime and justice*. Washington, DC: National Institute of Justice.
- Appelbaum, R. P., and B. Christerson. 1997. Cheap labor strategies and export-oriented industrialization: Some lessons from the East Asia/Los Angeles apparel connection. *International Journal of Urban and Regional Research* 21: 202-17.
- Appelbaum, R., D. A. Smith, and B. Christerson. 1993. Commodity chains in the Pacific Rim: Garment trade and manufacturing. In *Commodity chains and global capitalism*, edited by G. Gereffi and M. Korzeniewicz. Westport, CT: Greenwood Press.
- Arnold, C. G., and R. P. Appelbaum. 1995. The use of GIS to measure spatial patterns of ethnic firms in the Los Angeles garment industry. In *Anthropology through geographic information and analysis*, edited by H. Maschner and M. Aldenderfer. New York: Oxford University Press.
- Arthur, B. A. 1989. Increasing returns, competing technologies and lock-in by historical small events: The dynamics of allocation under increasing returns to scale. *Economic Journal* 99: 116-31.
- Arthur, B. A., S. N. Durlauf, and D. A. Lane. 1997. *The economy as an evolving complex system II*. Reading, MA: Addison-Wesley.
- Aten, B. 1997. Does space matter? International comparisons of the prices of tradables and non-tradables. *International Regional Science Review* 20: 35-52.
- Berk, R. 1992a. Research priorities for the human dimensions of global environmental change. In *Global environmental change*, NATO ASI Series Vol. 1, edited by P. Anderson, J. Eddy, and R. Corell. Newbury Park, CA: Sage.
- . 1992b. Studying the human dimensions of global climate change. In *Global climate change and California: Potential impacts and responses*, edited by N. Dowling and J. Knox. Davis: University of California Press.
- Besley, T., and A. Case. 1995. Incumbent behavior: Vote-seeking, tax-setting and yardstick competition. *American Economic Review* 85: 25-45.
- Beyer, P. 1994. *Religion and globalization*. Thousand Oaks, CA: Sage.
- Block, C. R. 1998. The GeoArchive: Information foundation for community policing. In *Crime mapping and crime prevention*, edited by D. Weisburd and T. McEwen. Monsey, NY: Criminal Justice Press.
- Block, R., and C. Block. 1995. Space, place and crime: Hot-spot areas and hot places of liquor related crime. In *Crime and place*, edited by J. E. Eck and D. Weisburd. Monsey, NY: Criminal Justice Press.
- Bockstael, N. 1996. Modeling economics and ecology: The importance of a spatial perspective. *American Journal of Agricultural Economics* 78: 1168-80.
- Bonacich, E., and R. P. Appelbaum. 2000. *Behind the label: Inequality in the Los Angeles garment industry*. Berkeley: University of California Press.
- Borjas, G. J. 1995. Ethnicity, neighborhoods and human-capital externalities. *American Economic Review* 85: 365-90.
- Bray, F. 1998. A stable landscape? Social and cultural sustainability in Asian rice systems. In *Sustainability of rice in the global food system*, edited by N. G. Dowling, S. M. Greenfield, and K. S. Fischer. Los Banos, Philippines: International Rice Research Institute.
- Brown, C., S. Doumbia, A. Dicko, M. Bagayogo, D. Mokadam, J. Regens, Y. Toure, D. Hodges, O. Doumbou, J. Beier, J. Gerone, and D. Krogstad. 1998. Mapping the risk of severe malaria in Cansoumana, Mali: GIS methods for studying malaria at the village level. Paper presented at 3d National Conference, Geographic Information Systems in Public Health, 17-20 August, San Diego, California.
- Bruelckner, J. 1998. Testing for strategic interaction among local governments: The case of growth controls. *Journal of Urban Economics* 44: 438-67.
- Bullard, R. 1994. *Unequal protection: Environmental justice and communities of color*. San Francisco: Sierra Club Books.
- Case, A., H. S. Rosen, and J. R. Hines. 1993. Budget spillovers and fiscal policy interdependence: Evidence from the states. *Journal of Public Economics* 52: 285-307.

- Chambliss, W. J. 1994. Policing the ghetto underclass: The politics of law and law enforcement. *Social Problems* 41: 177-94.
- Chomitz, K. M., and D. A. Gray. 1995. Roads, land use, and deforestation: A spatial model applied to Belize. *The World Bank Economic Review* 10: 487-512.
- Christerson, B. 1994. World trade in apparel: An analysis of trade flows using the gravity model. *International Regional Science Review* 17: 151-66.
- Christerson, B., and R. P. Appelbaum. 1995. Global and local subcontracting: Space, ethnicity, and the organization of apparel production. *World Development* 23: 1363-74.
- Cohen, J., D. Cork, J. Engberg, and G. Tita. 1998. The role of drug markets and gangs in local homicide rates. *Homicide Studies* 2: 241-62.
- Collin, R. W., and W. Harris. 1993. Race and waste in two Virginia communities. In *Confronting environmental racism: Voices from the grassroots*, edited by R. D. Bullard. Boston: South End Press.
- Craig, W., and S. Elwood. 1998. How and why community groups use maps and geographic information. *Cartography and Geographic Information Systems* 25: 95-104.
- Cressie, N. A. 1993. *Statistics for spatial data*. New York: John Wiley & Sons.
- Darian-Smith, E. 1999. *Bridging divides: The channel tunnel and English legal identity in the new Europe*. Berkeley: University of California Press.
- David, P. A. 1999. Krugman's economic geography of development: NEGs, POGs and naked models in space. *International Regional Science Review* 22: 162-72.
- DeFrances, C. J., and S. K. Smith. 1996. *Perceptions of neighborhood crime, 1995*. Bureau of Justice Statistics Special Report no. NCJ-165811. Washington, DC: U.S. Department of Justice.
- DeFronzo, J., and L. Hannon. 1998. Welfare assistance levels and homicide rates. *Homicide Studies* 1: 31-45.
- Durlauf, S. N. 1997. Statistical mechanics approaches to socioeconomic behavior. In *The economy as an evolving complex system II*, edited by B. Arthur, S. N. Durlauf, and D. A. Lane. Reading, MA: Addison-Wesley.
- Elwood, S., and H. Leitner. 1998. GIS and community-based planning: Exploring the diversity of neighborhood perspectives and needs. *Cartography and Geographic Information Systems* 25: 77-88.
- Entwisle, B., R. R. Rindfuss, S. J. Walsh, T. P. Evans, and S. R. Curran. 1997. Geographic information systems, spatial network analysis, and contraceptive choice. *Demography* 34: 171-87.
- Epstein, P. R. 1998. Health applications of remote sensing and climate modeling. In *People and pixels: Linking remote sensing and social science*, edited by D. Liverman, E. F. Moran, R. R. Rindfuss, and P. C. Stern. Washington, DC: National Academy Press.
- Escobar, A. 1995. *Encountering development: The making and unmaking of the third world*. Princeton, NJ: Princeton University Press.
- Fingleton, B. 1999. Estimates of time to economic convergence: An analysis of regions of the European Union. *International Regional Science Review* 22: 5-34.
- Friedland, R., and R. Hecht. 1996. *To rule Jerusalem*. New York: Cambridge University Press.
- Fujita, M., P. Krugman, and A. Venables. 1999. *The spatial economy: Cities, regions and international trade*. Cambridge, MA: MIT Press.
- Gallup, J. L., J. D. Sachs, and A. D. Mellinger. 1999. Geography and economic development. *International Regional Science Review* 22: 179-232.
- Gatrell, T., and M. Loytonen. 1998. *GIS and health*. London: Taylor & Francis.
- Gereffi, G. 1994. The organization of buyer-driven global commodity chains: How U.S. retailers shape overseas production networks. In *Commodity chains and global capitalism*, edited by G. Gereffi and M. Korzeniewicz. Westport, CT: Greenwood Press.
- . 1997. The reorganization of production on a world scale: States, markets and networks in the apparel and electronics commodity chains. In *Regionalization and labour market interdependence in East and Southeast Asia*, edited by D. Campbell, A. Parisotto, A. Verma, and A. Lateef. New York: St. Martin's Press and Macmillan.

- Gerlach, M. L. 1992. *Alliance capitalism: The social organization of Japanese business*. Berkeley: University of California Press.
- Glaeser, E. L., H. D. Kallal, J. A. Scheinkman, and A. Schleifer. 1992. Growth in cities. *Journal of Political Economy* 100: 1126-52.
- Glaeser, E. L., B. Sacerdote, and J. A. Scheinkman. 1996. Crime and social interactions. *Quarterly Journal of Economics* 111: 507-48.
- Goodchild, M. F., M. J. Egenhofer, K. K. Kemp, D. M. Mark, and E. Sheppard. 1999. Introduction to the Varenus project. *International Journal of Geographic Information Science* 13: 731-45.
- Hamilton, G. G., and R. C. Feenstra. 1997. Varieties of hierarchies and markets. In *The economic organization of East Asian capital*, edited by M. Orrú, N. W. Biggart, and G. G. Hamilton. Thousand Oaks, CA: Sage.
- Hamilton, G. G., and C.-S. Kao. 1990. The institutional foundations of Chinese business: The family firm in Taiwan. *Comparative Social Research* 12: 135-51.
- Hancock, M. 1999. *Womanhood in the making: Domestic ritual and public culture in urban South India*. Boulder, CO: Westview Press.
- Harris, T., and D. Weiner. 1998. Empowerment, marginalization and community-integrated GIS. *Cartography and Geographic Information Systems* 25: 67-76.
- Harthorn, B. H. 1998. California farmworkers: Dilemmas in developing interventions for health and medical care concerns. *Human Organization* 57: 369-78.
- Harvey, D. 1996. *Justice, nature and the geography of difference*. Oxford: Basil Blackwell.
- Henderson, J. V. 1999. Overcoming the adverse effects of geography: Infrastructure, health, and agricultural policies. *International Regional Science Review* 22: 233-37.
- Ioannides, Y. M. 1997. Evolution of trading structures. In *The economy as an evolving complex system II*, edited by W. B. Arthur, S. N. Durlauf, and D. A. Lane. Reading, MA: Addison-Wesley.
- . 2000. Economic geography and the spatial evolution of wages in the United States. In *Advances in spatial econometrics 1*, edited by L. Anselin and R. Florax. Heidelberg: Springer-Verlag.
- Isard, W. 1956. *Location and space economy*. Cambridge, MA: MIT Press.
- Juergensmeyer, M. 1993. *The new cold war? Religious nationalism confronts the secular state*. Berkeley: University of California Press.
- . 1995. Can we live with religious nationalism? *Peace Review* 7: 17-22.
- Kearney, M. 1995. The local and the global—The anthropology of globalization and transnationalism. *Annual Review of Anthropology* 24: 547-65.
- Keith, M., and S. Pile. 1993. *Place and the politics of identity*. London: Routledge.
- Kitron, U. 1998. Landscape ecology and epidemiology of vector-borne diseases: Tools for spatial analysis. *Journal of Medical Entomology* 35: 435-45.
- Kolstad, C. 1998. Integrated assessment modeling of climate change. In *Economics and policy issues in climate change*, edited by W. D. Nordhaus. Washington, DC: Resources for the Future.
- Kposowa, A., and K. D. Breault. 1993. Reassessing the structural covariates for U.S. homicide rates: A county level study. *Sociological Forces* 26: 27-46.
- Krugman, P. 1991a. *Geography and trade*. Cambridge, MA: MIT Press.
- . 1991b. Increasing returns and economic geography. *Journal of Political Economy* 99: 438-99.
- . 1996. Urban concentration: The role of increasing returns and transport costs. *International Regional Science Review* 19: 5-30.
- . 1999. The role of geography in development. *International Regional Science Review* 22: 142-61.
- Land, K., P. McCall, and L. Cohen. 1990. Structural covariates of homicide rates: Are there invariances across time and social space? *American Journal of Sociology* 95: 922-63.
- Lawson, A., A. Biggeri, D. Böhning, E. Lesaffre, J.-F. Viel, and R. Bertollini. 1999. *Disease mapping and risk assessment for public health*. New York: John Wiley & Sons.

- Lee, C. 1993. Beyond toxic waste and race. In *Confronting environmental racism: Voices from the grass-roots*, edited by R. D. Bullard. Boston: South End Press.
- Logan, J., and H. L. Molotch. 1987. *Urban fortunes: The political economy of place*. Berkeley: University of California Press.
- Longley, P. A., M. F. Goodchild, D. J. Maguire, and D. W. Rhind. 1999. *Geographical information systems*. 2nd ed. New York: John Wiley & Sons.
- Martin, R. 1999. The new geographical turn in economics: Some critical reflections. *Cambridge Journal of Economics* 23: 65-91.
- Messner, S. F., L. Anselin, R. Baller, D. Hawkins, G. Deane, and S. Tolney. 1999. The spatial patterning of county homicide rates: An application of exploratory spatial data analysis. *Journal of Quantitative Criminology* 15: 423-50.
- Mohanty, C., A. Russo, and L. Torres. 1991. *Third world women and the politics of feminism*. Bloomington: Indiana University Press.
- Molotch, H. L. 1995. Art in economy: How aesthetics and design are building Los Angeles. *Competition and Change* 1: 145-85.
- Moran, E. F., and E. Brondizio. 1998. Land-use change after deforestation in Amazonia. In *People and pixels: Linking remote sensing and social science*, edited by D. Liverman, E. F. Moran, R. R. Rindfuss, and P. C. Stern. Washington, DC: National Academy Press.
- Morenoff, J., and R. J. Sampson. 1997. Violent crime and the spatial dynamics of neighborhood transition: Chicago 1970-1990. *Social Forces* 76: 31-64.
- Murdoch, J., T. Sandler, and K. Sargent. 1997. A tale of two collectives: Sulphur versus nitrogen oxides emission reduction in Europe. *Economica* 64: 281-301.
- National Center for Geographic Information and Analysis. 1999. *Fundamental research in geographic information and analysis* [CD-ROM]. Santa Barbara, CA: National Center for Geographic Information and Analysis.
- Nelson, G. C., and D. Hellerstein. 1997. Do roads cause deforestation? Using satellite images in econometric analysis of land use. *American Journal of Agricultural Economics* 79: 80-88.
- O'Loughlin, J., M. D. Ward, C. L. Lofdahl, J. S. Cohen, D. S. Brown, D. Reilly, K. S. Gleditsch, and M. Shin. 1999. The diffusion of democracy, 1946-1994. *Annals of the Association of American Geographers* 88: 545-74.
- Orrú, M., N. W. Biggart, and G. G. Hamilton, eds. 1997. *The economic organization of East Asian capital*. Thousand Oaks, CA: Sage.
- Rauch, J. E. 1999. The role of transportation costs for people. *International Regional Science Review* 22: 173-78.
- Reagan, P. B. 1998. Proximity to hospitals and preventive health care for young children. Paper presented at 3d National Conference, Geographic Information Systems in Public Health, 17-20 August, San Diego, California.
- Rey, S. J., and B. D. Montouri. 1999. US regional income convergence: A spatial econometric perspective. *Regional Studies* 33: 143-56.
- Roncek, D. 1993. Mapping crime: An inescapable but valuable task for intracommunity analysis. In *Questions and answers in lethal and non-lethal violence*, edited by C. Block and R. L. Block. Washington, DC: National Institute of Justice.
- Sampson, R. J., J. Morenoff, and F. Earls. 2000. Beyond social capital: Neighborhood mechanisms and structural sources of collective efficacy for children. *American Sociological Review*.
- Sassen, S. 1993. *The global city: New York, London, Tokyo*. Princeton, NJ: Princeton University Press.
- . 1994. *Cities in a world economy*. Thousand Oaks, CA: Pine Forge Press.
- . 1996. *Losing control? Sovereignty in an age of globalization*. New York: Columbia University Press.
- Scott, A. J., and E. W. Soja. 1998. *Los Angeles and urban theory at the end of the twentieth century*. Berkeley: University of California Press.

- Sever, T. L. 1998. Validating prehistoric and current social phenomena on the landscape of the Petén, Guatemala. In *People and pixels: Linking remote sensing and social science*, edited by D. Liverman, E. F. Moran, R. R. Rindfuss, and P. C. Stern. Washington, DC: National Academy Press.
- Shiva, V. 1989. *Staying alive: Women, ecology and development*. London: Zed Books.
- Soja, E. W. 1997. *Postmodern geographies: The assertion of space in critical social theory*. London: Verso.
- Starr, H. 1991. Democratic dominoes: Diffusion approaches to the spread of democracy. *Journal of Conflict Resolution* 35: 6-31.
- Stonich, S. C. 1998a. Information technologies, advocacy, and development. *Cartography and Geographic Information Systems* 25: 113-22.
- . 1998b. The political ecology of tourism. *Annals of Tourism Research* 25: 25-54.
- Storper, M., and R. Walker. 1989. *The capitalist imperative: Territory, technology and industrial growth*. New York: Basil Blackwell.
- Szasz, A. 1994. *Ecopopulism: Toxic waste and the movement for environmental justice*. Minneapolis: University of Minnesota Press.
- Talen, E. 1999. Constructing neighborhoods from the bottom up: The case for resident-generated GIS. *Environment and Planning B* 26: 533-54.
- . 2000. Perceptual GIS: A new tool for individual and group expression in participatory planning. *Journal of the American Planning Association* 66.
- Tolnay, S. E. 1995. The spatial diffusion of fertility: A cross-sectional analysis of counties in the American South, 1940. *American Sociological Review* 60: 299-308.
- Tolnay, S. E., G. Deane, and E. M. Beck. 1996. Vicarious violence: Spatial effects on Southern lynchings, 1890-1919. *American Journal of Sociology* 102: 788-815.
- U.S. Bureau of Justice Statistics. 1997. *Criminal victimization 1996: Changes 1995-96 with trends 1993-96*. Washington, DC: U.S. Bureau of Justice Statistics.
- Venables, A. J. 1999. But why does geography matter, and which geography matters? *International Regional Science Review* 22: 238-41.
- Walsh, S. J., P. H. Page, and W. M. Gesler. 1997. Normative models and healthcare planning: Network-based simulations within a geographic information system environment. *Health Services Research* 32: 243-60.
- Ward, M. D. 1992. *The new geopolitics*. London: Gordon and Breach.
- Whitely, R. 1992. *Business systems in East Asia: Firms, markets, and societies*. Newbury Park, CA: Sage.
- . 1996. Business systems and global commodity chains: Competing or complementary forms of economic organization. *Competition and Change* 1: 411-25.
- Wilson, W. J. 1987. *The truly disadvantaged: The inner city, the underclass, and public policy*. Chicago: University of Chicago Press.
- . 1997. *When work disappears: The world of the new urban poor*. New York: Alfred A. Knopf.
- Wood, C., and D. Skole. 1998. Linking satellite, census, and survey data to study deforestation in the Brazilian Amazon. In *People and pixels: Linking remote sensing and social science*, edited by D. Liverman, E. F. Moran, R. R. Rindfuss, and P. C. Stern. Washington, DC: National Academy Press.