Center for Spatially Integrated Social Science

FINAL REPORT TO NSF

University of California, Santa Barbara

December 2005

FINAL REPORT TO NSF

Center for Spatially Integrated Social Science
University of California, Santa Barbara
3510 Phelps Hall
Santa Barbara CA 93106-4060

Office: (805) 893-8224
Fax: (805) 893-8617
URL: CSISS.org
Email: mailto:CSISS@CSISS.org

December 2005

CENTER FOR SPATIALLY INTEGRATED SOCIAL SCIENCE

CENTER FOR SPATIALLY INTEGRATED SOCIAL SCIENCE
FINAL REPORT TO NSF, DECEMBER 2005

Summary

The Center for Spatially Integrated Social Science (CSISS) is an infrastructure program designed to facilitate communication and sharing of research ideas and methodologies among researchers in the social and behavioral sciences. The CSISS approach to integrating knowledge across disciplines and paradigms is to be achieved by broadening the user base of spatially integrated social science (SISS)—cartographic visualization, geographic information systems (GIS), pattern recognition, spatially sensitive statistical analysis, and place-based search methodologies. The Center's programs make use of Web technologies to promote accessibility to these tools and to related information, foster opportunities for scholars to learn about and master spatial methodologies, and provide intellectual foci for engaging a broad range of scholars in intensive discussion and program development.

CSISS was founded in 1999 with the aid of a five-year award from the National Science Foundation (NSF), under its program of support for the development of research infrastructure in the social and behavioral sciences. This report to NSF summarizes the contributions made by the center from its inception until December, 2005, at the end of a one-year no-cost extension. Although NSF core support for the center ended in September 2004, the project continues with its original objectives. Successful proposals have been made for other funding consistent with these objectives, and we anticipate that CSISS will continue to provide support for spatial social science for many years to come.

Since its inception in October 1999, CSISS has sponsored or co-sponsored a total of 37 residential workshops for graduate students and faculty (Summers of 2000, 2001, 2002, 2003, 2004, and 2005); and eight specialist meetings for faculty on spatial analytic themes of interest to the social science research community. Two new programs have been established under the auspices of CSISS that will provide continued funding after the end of core NSF funding: the SPACE program, funded by NSF's Division of Undergraduate Education, which provides workshops for undergraduate educators in the social sciences; and the GIS and Population Science program, funded by the National Institute of Child Health and Human Development, which provides workshops for researchers in demography and population science.

By the end of the summer 2005 workshop period, a total of 384 scholars had participated in CSISS-sponsored workshops, more than 220 had contributed to the success of specialist meetings, and another 400 had benefited from workshops co-sponsored by CSISS. Many more participated in CSISS-sponsored events at annual meetings of learned societies— these have included the American Anthropological Association, the Population Association of America, the Regional Science Association, the American Sociological Association, the Rural Sociology Society, the American Agricultural Economics Association, the Southern Demography Association, the American Society of Criminology, the Association of American Geographers, and the Social Science History Association.

The CSISS Best Practice book *Spatially Integrated Social Science* was published by Oxford University Press in 2004 and has been well received. Another book, *Advances in Spatial Econometrics. Methodology, Tools and Applications*, edited by Luc Anselin, Raymond Florax, and Serge Rey, was published by Springer-Verlag, also in 2004.

The CSISS program of support for the development of spatial tools, directed at the University of Illinois, Urbana-Champaign by Luc Anselin, has been one of the most conspicuous of the CSISS activities. Its most successful product has been GeoDa, a package for spatial statistics and exploratory spatial data analysis that is readily integrated with popular GIS products. To date over 8,500 researchers have downloaded the software, and it has been featured in many presentations and workshops.

The CSISS Web resources include a range of bibliographic materials, learning resources, and engines for conducting specialized searches over the CSISS site and over the Internet. Currently an average of over 1,000 distinct users visit the site per day, and it provides an effective method of communicating information about CSISS programs, and managing participation in CSISS activities.

CSISS was founded at a very appropriate point in the history of the social sciences, when many scholars from a wide range of disciplines were beginning to acknowledge the importance of space and time for providing context to observations, a means of organizing knowledge, a basis for addressing and modeling such fundamental social concepts as interaction, separation, and connectivity, and as an element in evolving theory. This "spatial turn" has gathered momentum during the past six years, fuelled in part by the availability of data and tools, and we hope in no small degree by the activities of CSISS. The CSISS concept has been adopted in several other parts of the world, most notably in the new Research Network in Spatially Integrated Social Science, funded by the Australian Research Council (siss.edu.au). Objective measurement of such underlying trends in scholarship is notoriously difficult, but CSISS has collected numerous statistics, such as the prevalence of spatial thinking in the literature, interest in our workshops, the results of surveys of CSISS participants, and activity on our website, all of which support the assertion that interest in space is growing apace, and that NSF funding has had a significant impact on the ability of social scientists to make use of spatial thinking, tools, data, and perspectives in their research.

Table of Contents

CENTER FOR SPATIALLY INTEGRATED SOCIAL SCIENCE
BACKGROUND

The Center for Spatially Integrated Social Science was established in 1999 with a grant from the National Science Foundation's Directorate for Social, Behavioral, and Economic Research (SBE). The CSISS award was one of six given in 1999 under SBE's initiative to build research infrastructure in the social and behavioral sciences.

CSISS recognizes the key role space plays in human society, and promotes research that advances understanding of spatial patterns and processes. The tools of spatially integrated social science (SISS)—cartographic visualization, geographic information systems (GIS), pattern recognition, spatially sensitive statistical analysis, and place-based search methodologies—are used to integrate knowledge across disciplines and paradigms. From research design to the interpretation of research findings, the use of SISS can advance understanding in nearly every domain of the social and behavioral sciences.

The management structure for CSISS includes an Advisory Board of prominent social science researchers and an Executive Committee consisting of Principal Investigators, Senior Researchers, and a Program Director. The Advisory Board has met five times, in May 2000, December 2000, October 2001, October 2002, and December 2003. The Science Advisory Board reviews all Center activities and plans, and reports to the Executive Committee. During the period of core NSF funding the Advisory Board also reported to NSF. The Executive Committee convenes at least once a month to review the actual implementation of the various programs within its mandate (the Executive Committee has met less frequently since the end of core NSF funding).

CSISS activities are organized under seven programs:

(1) sponsorship of **specialist meetings** on major themes in the social sciences;
(2) **national summer workshops** in new methods, aimed at young scholars;
(3) development of new **tools for spatial analysis** based on emerging software technologies;
(4) preparation of Web-accessible **learning resources** covering all aspects of the spatial approach;
(5) identification of **best-practice examples** of spatial analysis in the social sciences, converting these into publications and learning resources that demonstrate authoritative applications of spatial perspectives.
(6) implementation of **place-based search** tools for identifying and delivering geographically referenced information on the WWW and in digital libraries; and
(7) creation of a **virtual community** of Web-based services to the social sciences.

This report outlines progress towards fulfilling the objectives in the period from the center's inception until December 2005.[1]

CSISS PROGRAMS

To fulfill its objectives, CSISS has formulated its strategic plan around the execution of seven interrelated programs. These programs focus on the methods, tools, techniques, software, data access, and other services needed to promote and facilitate a spatially integrated approach to the social sciences. Activities related to each of these programs over the period from 1 October 1999 through 30 November 2005 are described in the following sections. More detailed information on all of these activities is available through www.CSISS.org and in the annual reports submitted to NSF in 2000, 2001, 2002, and 2003.

I.   Specialist Meetings

CSISS organizes meetings on core issues in the social sciences that cut across traditional disciplinary boundaries to focus on gaps in knowledge that can be addressed through a spatial perspective. Topically, these meetings address traditional domains of social science inquiry (e.g., equity, cultural analysis, externalities, and globalization), as well as new areas of investigation where spatial perspectives and technologies might add value (e.g., location-based services that exploit GPS and wireless technologies). These meetings identify scientific agendas and workshop needs for young scholars, propose learning resources essential to the diffusion of tools and concepts, suggest the creation of new spatial research tools, explore dissemination practices to reach potential users of spatial perspectives, foster collaborative networks among meeting participants, and develop best-practice publications of exemplary social science applications.

Specialist meetings were not part of the original proposal to NSF, but were instituted early in the project in response to a recommendation from the Science Advisory Board, as a way of building stronger links between CSISS programs and substantive social science inquiry.

A total of eight such meetings were held in the period covered by this report. These are described briefly below; the objectives, agendas, participant lists, reports, and supporting materials can be found on the CSISS Website.

Specialist Meeting on Social Inequality and Equity
Upham Hotel, Santa Barbara, November 13–14, 2000

The purpose of the meeting was to identify ways in which CSISS could better achieve its goal of supporting the development and dissemination of spatial theories, tools, concepts and techniques in the social sciences, with reference to studying and addressing problems of social inequality and equity.

The workshop brought together twenty-one specialists from diverse disciplines (sociology, anthropology, criminology, political science, economics, geography, biostatistics, transportation engineering, and history), representing an equally diverse range of substantive interests in inequality which we categorized into four broad groupings: access, crime and social justice, urban inequality (including racial, and ethnic stratification), and economic inequality and labor markets. The meeting was co-chaired by Richard Appelbaum (Sociology and Global & International Studies, UCSB) and Helen Couclelis (Geography, UCSB); the Steering Committee included Appelbaum and Couclelis, along with John Logan (Sociology, SUNY-Albany, now Brown University) and John Sprague (Political Science, Washington University).

The specific goals of the meeting were:
1. To identify research questions related to inequality and equity, where consideration of the spatial dimensions of the issues has led to, or is most likely to lead to, new insights. This includes the identification of issues requiring new developments in spatial theory, methodology or technology.
2. To identify specific learning materials and best practice examples that could be collected, developed, and disseminated by CSISS through its virtual community, to support research and instruction on the spatial aspects of inequality and equity.
3. To identify and prioritize specific software tools, including methods, statistical techniques, platforms, and implementations, that CSISS could refine or further develop to support research.
4. To suggest future CSISS workshops and specialist meetings based on the foregoing issues and concerns.

The workshop concluded with discussions on three cross-cutting issues: problems of data and visualization; the use of public data (including confidentiality issues); and opportunities afforded by Census 2000 and Congressional redistricting. In all of these discussions, there was a tacit agreement that space should be made a more central, explicit concept in social science. This is already true of some disciplines (for example, human geography and, increasingly, anthropology), but in general, social theories need to be brought into spatial representation and analysis. Within the GIS paradigm, the center of activity needs to move from formal modeling of spatial processes with highly refined spatial statistics to relating these models more directly to underlying social processes. A dominant critique concerned temporal factors, which are implicit in social processes, and that cannot be excluded from spatial questions and from spatial techniques and technologies. CSISS was encouraged to offer advice to software producers, and to provide programs (e.g., workshops) to assist social scientists with the problems of data visualization on maps. A wide range of potential learning materials and best practice examples were identified by participants, which will be incorporated into the CSISS website.

Specialist Meeting on Spatial Externalities
Upham Hotel, Santa Barbara, January 11–13, 2001

The meeting participants consisted of a group of leading scholars from a range of fields in economics, including urban and regional economics/regional science, real estate economics, environmental economics, and natural resource economics. The steering committee included Luc Anselin (chair), Jan Brueckner (Department of Economics, University of Illinois, Urbana-Champaign, now University of California, Irvine), and Robert Deacon (Department of Economics, UCSB). The singular focus on economics as a discipline was motivated by the perceived lack of dissemination of a spatial perspective in economics relative to the progress made in other social sciences.

The objectives of the specialist meeting were two-fold:

- To assess the status and future of "spatial thinking" in economics in general, and in the context of the study of spatial externalities in particular. Specifically, participants were asked to address the perceived added value of spatial models and spatial methods, to identify critical impediments, and to suggest the most promising research directions where a spatial perspective can provide added value to the solution of economic questions.
- To assess the infrastructure needs to enhance and facilitate spatial thinking in economics and other social sciences. Specifically, this included identifying critical needs for learning materials, topics suitable for the organization of workshops, priorities in software tool development, and other materials for inclusion in the CSISS virtual-community framework.

The meeting was organized around three main topics: theoretical perspectives on spatial externalities; methodological perspectives on spatial externalities; and spatial analysis in economic research. Each topic was introduced by a short overview presentation by the session moderator, followed by brief statements from a subset of the participants, and then opened for general discussion. In addition, presentations were made on the overall goals of CSISS and the vision of spatial analysis as an integrating force, on the various CSISS programs dealing with learning materials, best practices, and workshops, and on the CSISS software tools program. In addition, participants presented materials on promising data sources for use in the study of agglomeration economies and real estate analysis.

Some common themes that emerged from the wide ranging discussion were the importance of space and scale in the measurement of economic phenomena (particularly in the interaction between economics and natural phenomena), the role of space in the conceptualization of interaction, and the necessity of proper model specification, identification, and closure (equilibrium conditions). Specific recommendations for future CSISS activities included holding specialist meetings on the role of space in real estate analysis and in environmental economics, and on the frontier of methods in spatial econometrics. Suggestions for workshops included a strong endorsement of existing workshops on spatial data analysis and a new workshop on locational equilibrium models (non-market valuation). In terms of software tools, the need was identified for a

computational infrastructure, with an emphasis on modularity, and on a role for CSISS to serve as a clearinghouse for spatial analysis software (and data access). Interest was expressed to start a collection of best practices to promote spatial analysis in economics. The meeting resulted in a special issue of the *International Regional Science Review* in 2003 [26(3)].

Location-Based Services
Upham Hotel, Santa Barbara, December 14–15, 2001

The Global Positioning System and cellular technologies are enabling a new generation of electronic devices that know where they are, and are capable of modifying the information they collect and present based on that knowledge. The Wireless Communication and Public Safety Act of 1999 permits operators of cellular networks to release the geographic locations of users in certain emergency situations, and a range of electronic services are now being developed and offered to assist users in finding nearby businesses and other facilities. A location-based service (LBS) can be defined as an information service that exploits the ability of information technology to know where it is, and to modify the information it presents accordingly. The Open GIS Consortium has begun a number of initiatives related to technical specifications for LBS.

CSISS and the University Consortium for Geographic Information Science organized a specialist meeting to explore these new services, and their implications and significance for the social sciences and for geographic information science. Specific issues addressed included:

- the use of LBS to support primary data capture in the social sciences, with emphasis on spatial and temporal components;
- requirements for new representations, and for analytic tools to visualize and investigate such data;
- privacy and related issues associated with LBS data;
- new forms of social behavior enabled by LBS;
- new technologies that extend current concepts of LBS;
- needs for learning materials, examples, and other resources that could help to facilitate social-science research related to LBS; and
- the use of LBS-derived data for modeling in the social sciences.

A steering committee was named in mid-2001, selected participants were invited, and an open call for participation was issued. Some 30 applications were received, and 10 accepted. In total, the workshop included approximately 30 participants.

Specialist Meeting on New Tools for Spatial Data Analysis
Upham Hotel, Santa Barbara, May 10–12, 2002

The specialist meeting was co-chaired by Luc Anselin and Segio Rey, assisted by a steering committee consisting of Richard Berk (UCLA), Di Cook (Iowa State), Mark Gahegan (Pennsylvania State), Geoffrey Jacquez (BioMedware), and Ayse Can Talen (Fannie Mae Foundation).

The objectives of the meeting were threefold. First, it provided an opportunity to demonstrate, showcase, and benchmark state-of-the-art tools and to interact with other specialized developers. Second, it facilitated and promoted a dialog among the wide range of developers about priorities and guidelines for software design, data and model standards, inter-operability, and open environments. Third, the meeting also served as a way to introduce CSISS's software development initiatives and served as a forum to obtain feedback and comments.

Participants for the meeting were solicited using a dual approach consisting of targeted invitations and an open call for participation. All respondents to the call were required to submit an abstract. A final list of participants was selected by the steering committee. All participants submitted a full paper for inclusion in the meeting's Proceedings, edited by Anselin and Rey.

The two-day meeting was organized around a format of plenary presentations, followed by in-depth discussion in breakout groups, with a report back to the plenary meeting. After two introductory presentations on the CSISS program and the goals of the workshop, there were four themes: (1) Discovery and inference, computational support for constructing geographic knowledge (Mark Gahegan); (2) Spatial models and spatial modeling (Roger Bivand); (3) Software architectures for spatial data analysis (Geoffrey Jacquez); (4) User perspectives (Asye Can). In addition, there was an open "posture session" on the first evening, where several participants demonstrated their software.

Considerable discussion ensued after the breakout session presentations, but some common themes emerged:
- the need for communication of user needs to software developers (STEPs, spatial tools enhancement proposals)
- open environments, interoperability, high-level interfaces
- the need for standards (data documentation, methods documentation, software architectures)
- the usefulness of "show and tell" sessions and for opportunities for developers to interact.
- the need for benchmarks (both data sets as well as "correct" results)
- the need to continue communication

There was a strong sense to build upon the momentum of the meeting and to continue interaction. In addition, suggestions were made to develop two white papers, one devoted to software architecture, another to the "core" tools that would need to be included in any toolbox. Also, Anselin and Rey solicited additional papers for individuals who were not

able to participate in the meeting but expressed strong interest. The complete collection of papers was included on a Proceedings CD, distributed by CSISS. The meeting resulted in a special issue of *Geographical Analysis* to be published in 2006 [38(1)].

Spatial and Social Interactions in Economics
Upham Hotel, Santa Barbara, 4–5 April, 2003

Empirical analysis of spatial and social interactions by economists was quite limited until about a decade ago, when interest and activity grew on a number of fronts simultaneously. These include the study of peer effects within schools and classrooms, a rebirth of urban economics, the "new" growth theory in macroeconomics based on education externalities, the development of theoretical models of social learning and information cascades, and the application of the techniques of "labor-metrics"—a research style developed in labor economics—to empirical questions in epidemiology and environmental economics.

Despite this resurgence of interest in spatial and social interactions within economics, GIS and related advances in geography have to date made relatively few inroads into the economics profession. This has been reflected, in part, in the relatively low participation of economists in CSISS workshops during the first few years of CSISS operation. The goal of this meeting, which was organized by Peter Kuhn, was to make a major outreach by CSISS to the economics community, with the aim of disseminating these advances into economics. This was accomplished by bringing together cutting-edge researchers on spatial and social interactions in the economics profession, having them present examples of their current research on spatial issues, exposing them to information on new developments in GIS and new spatial econometric software, and initiating a discussion on possible uses of these tools, as well as further development of these tools, within economics.

The outcomes of the meeting were at least seven-fold. First, as a result of both Luc Anselin's and Mike Goodchild's presentations, the meeting exposed an influential group of economists to new developments in spatial econometrics and software of which many had been unaware. In fact, according to a follow-up survey, fully 95% of respondents indicated that the meeting introduced them "to spatial tools, data, or ways of thinking that were new to (them)". Conversations with participants revealed particular enthusiasm for the ability of spatially weighted regression to estimate spatially varying coefficients, and for mapping software that allowed one to "pan" across a map to see how such coefficients varied across space. Second, the meeting appears very likely to change the future direction of research among those who attended; in fact ninety percent of respondents reported that the meeting was moderately or very helpful in advancing their own research. More importantly, fully 96 percent of respondents indicated that the meeting was likely to add a *spatial dimension* to their future research. Of this 96 percent, 52 percent said the extent of this influence on their research would be "considerable" or "a great deal". Since many of the conference participants are highly regarded researchers in the economics profession, the influence of space in economics seems very likely to spread as a result of this meeting.

Third, the meeting created the foundations of new research community in the area of spatial and social interactions in economics. Working on their own, some of the economists who attended had previously felt isolated within their profession; bringing them together provided a sense to all involved that a critical (but previously scattered) mass does indeed exist in the economics profession in the spatial area. This was reflected in a great deal of enthusiasm among the participants to find a way to continue meeting and collaborating (on which we elaborate further below). Fourth, a number of new interdisciplinary links among faculty were forged. These included links between geographers and econometricians (for example Luc Anselin and Tim Conley), geographers and economists (Stuart Sweeney and Enrico Moretti), and economists and hydrologists (Olivier Deschenes and Jeff Dozier). These links can be expected to enhance the future research productivity of all involved, and again to foster the penetration of spatial perspectives into economics. Fifth, the meeting had a considerable impact on graduate students in both geography and economics, in part simply because they were introduced to students in the other discipline; in part because they were exposed to top-flight research of common interest. A likely consequence is that the economists among them may be more likely to pick a spatial topic, or simply to treat space in a more sophisticated manner, in their dissertation research. Graduate students in geography benefited from exposure to economists' perspectives on how to distinguish causal connections from simple spatial correlations using methods like instrumental variables and natural experiments that have not made substantial inroads into geography. In fact, in anticipation of the benefits of this event to graduate students, UCSB's graduate division contributed special funding to facilitate graduate student participation in the meeting.

Sixth, based on information on future funding opportunities provided by NSF representative Kwabena Gyimah-Grempong, the meeting provided a jumping-off point for future joint research and funding initiatives between economists and geographers. Of the faculty responding to the follow-up survey, 79 percent indicated they would be interested in approaching NSF for funding to continue meetings and activities of this kind. Finally, the papers presented at the meeting are accessible to the broader community, especially of non-economists, via the CSISS website, thus reaching an audience they might not otherwise reach.

Spatial Analysis of Health-Risk Perception
Upham Hotel, Santa Barbara, 10–11 October 2003

This specialist research meeting was organized by Barbara Herr Harthorn, Laura Oaks, and Susan Stonich, all of the Department of Anthropology, UCSB. It convened an interdisciplinary group of 20 behavioral scientists and health researchers whose work has centered on the areas of social risk theory, cultural constructions of health and risk, and spatial analysis of health. The purpose of the meeting was to explore common grounds for new interdisciplinary research proposals that bring together spatial analysis with work looking at perception of health risk. People's perceptions of health risks are much more consistently associated with their behavior than are either the epidemiological distribution of risk factors in populations, or experts' judgments and communications about risk and risk factors. Judgments about risk acceptability have also assumed a central position in

the current global geopolitical environment (e.g., in relation to food safety, location of infrastructure systems, migration and immigration, infectious diseases, and worker safety, to name only a few). Spatial analysis of health-risk perception offers the possibility of helping to resolve paradoxical aspects of the social amplification of risk as well as processes of optimistic bias associated with risky behaviors, yet it is a largely unexplored arena. This two-day meeting alternated formal presentations with extensive discussion. Outcomes include networking that may lead to new collaborative research proposals to the NSF (e.g., under the Spatial Social Science component of the Human Social Dynamics initiative) and the NIH (where the poor response of the lay public to conventional risk communication continues to be one of the most serious problems), a larger, international research conference and resultant publication(s), and dissemination of spatial analysis tools through CSISS. Relevant federal agency representatives were invited to attend.

Globalization in the World-System: Mapping Change over Time
University of California, Riverside, 7–8 February, 2004

This specialist meeting was co-sponsored by CSISS and the Institute for Research on World Systems and the Vice Chancellor for Research at the University of California, Riverside (UCR). It was organized by Richard P. Appelbaum (CSISS, Sociology, UCSB), Christopher Chase-Dunn (IRWS, Sociology, UCR), and Helen Couclelis (CSISS, Geography, UCSB).

A number of prominent scholars on globalization were invited to take a multi-disciplinary approach to research on globalization that uses new research technologies and sources of information not typically employed in globalization studies—especially temporal geographic information systems (TGIS). Discussion focused on worldwide studies of social processes and on projects that explicitly compare recent global processes with those that have operated in the past. The meeting also included reports on efforts to map the spatial scale and intensity of human interaction networks in order to study the emergence of global integration and its contemporary patterning. The meeting led to the formulation of specific research projects by subgroups of participants, particularly projects that employed TGIS analytic and visualization technology to shed light on issues of historical and contemporary globalization. This was accomplished with a format that enabled participants with substantive knowledge to interact with those who possessed technical sophistication in spatial and network analysis. Paper presentations addressed several pre-selected conference themes, including Commodity Chains in the World Economy, Global Business Networks, the Global City System, Hegemony and Power Configurations in Interstate Systems, Global Transportation and Communications Networks, and Transnational Social Movements.

GPS and Time-Geography Applications for Activity Modeling and Microsimulation

Upham Hotel, Santa Barbara, October 10–11, 2005

The intent of this Peer Exchange, sponsored by CSISS and the Federal HighWay Administration (FHWA), was to discuss potential approaches to using GPS vehicle traces for defining space–time paths and prisms to be used in activity modeling and microsimulation for transportation analysis. It brought together travel demand forecasters, experts in travel behavior and GPS data collection, and geographers to discuss different approaches to analyzing space–time prisms for transportation forecasting needs. A total of 23 invitees came from universities, state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and consulting groups. The goals of the meeting were as follows:

- To discuss methods and techniques for applying GPS data to activity modeling and microsimulation.
- To increase practitioner interest in the potential of GPS data for activity models.
- To encourage academics and their graduate students to pursue research activities with these datasets.
- To develop priorities for research that could be conducted using the Commute Atlanta dataset after it has been anonymized for public release.
- To develop priorities for research that could be conducted using other GPS data collected from other household travel/activity surveys.

Currently, many planning agencies are viewing activity- and tour-based models as desirable and feasible techniques for their transportation modeling practices. The development and implementation of activity, tour-based, and micro-simulation modeling approaches, however, require additional and more specialized data on travel activity patterns. As we now are able to collect GPS data over longer periods, e.g., 12 months of data, compared to a one-day travel diary, we can use this information to analyze personal space-time prisms. We can look at where people travel on a regular basis compared to places visited infrequently, or only once over a long period of time. We can examine the time they travel in relationship to the locations they travel, and if they shift their travel times much or not. Because it was nearly impossible to get this type of data except for a very small sample, the conceptualization and analysis of space-time prisms is in its early stages. GIS is only recently able to process and analyze these quantities of data. This type of data will be invaluable as travel demand modeling shifts toward microsimulation.

The most intriguing GPS dataset on household-vehicle travel in the United States, so far, is the Commute Atlanta data, a FHWA-sponsored value-pricing project, where 1-second GPS data over 12 months for 270 households with 487 vehicles were collected. Other long-period GPS data have been collected in Borlange, Sweden (www.rattfart.com). Another potential source is from another FHWA-sponsored value-pricing project, conducted by the Puget Sound Regional Council in Seattle.

II. National Workshops

CSISS sponsors intensive workshops of one week or more in duration, and provides participant scholarships to introduce the latest and most authoritative approaches to the methods and tools of spatially integrated social science. The primary client group for workshops includes PhD candidates, postdoctoral students, and untenured assistant professors. However, some senior scholars are included to provide a bridging across academic generations. Consistent with CSISS objectives, workshop invitees are selected from a broad mix of social-science disciplines. Effort is made during the workshops to build collaborative networks among participants by stressing the commonality of the spatial perspective to problem identification and research approaches.

Three types of such workshops are provided: those sponsored entirely by CSISS using its core NSF funds; those co-sponsored by CSISS in which more limited funding is provided from the core NSF funds; and those sponsored by CSISS under other funding. In addition, CSISS has offered shorter workshops at many national meetings of learned societies.

In the following sections we detail each of these types of workshops.

CSISS-Sponsored Residential Workshops Funded by NSF

Population Science and GIS
Pennsylvania State University, 19–23 May 2003
Topics covered: The uses of geospatial information technologies within the population sciences; applications to problems of urban poverty, neighborhood research, racial/ethnic diversity, maternal/child health, epidemiology, and population–environment; spatial analytical methods for demographic inquiry, issues in geospatial data handling, and using spatial analysis tools within GIS (ArcGIS 8.2, ArcView 3.3) for data visualization and modeling. No experience in spatial analysis was required.
Instructors: Stephen Matthews (coordinator), Mark Gahegan, and David O'Sullivan (all of Pennsylvania State University), Livia Montana (Macro International), Trudy Suchan (U.S. Census Bureau), David Wong (George Mason University), Frank Tanser (Medical Research Council, Durban, South Africa), and Paul Voss (University of Wisconsin, Madison).
Co-sponsors with CSISS and host institution: Pennsylvania State University (Population Research Institute, Social Science Research Institute, Department of Geography, and the GIS Council).

Accessibility in Space and Time: A GIS Approach
Ohio State University, 16–20 July, 2001; 22–26 July, 2002; 7–11 July, 2003
Topics covered: Measuring and analyzing accessibility in physical and social space, and in cyberspace; network approaches to connectivity and accessibility; graphical visualization and computational approaches to the analysis of individual space-time behavior; statistical modeling of spatial interaction patterns; and spatial optimization

techniques. Applications and exercises will feature a range of social science issues. No experience in GIS required.

Instructors: Mei-Po Kwan (coordinator), Alan Murray, Morton O'Kelly, Michael Tiefelsdorf (all of Ohio State University), Irene Casas (SUNY Buffalo).

Co-sponsor with CSISS and host institution: Department of Geography, Ohio State University.

Introduction to Spatial Pattern Analysis in a GIS Environment

University of California, Santa Barbara, 14–18 August, 2000; 6–10 August, 2001; 29 July–2 August, 2002; 28 July–1 August, 2003; 28 June–2 July, 2004.

Topics covered: Introduction to concepts in GIS, spatial pattern analysis (exploratory and confirmatory), autocorrelation statistics, and geostatistics (including variogram analysis and kriging). Lectures cover research methods in spatial pattern analysis in the social sciences. Exercises include an introduction to ArcInfo 8.0 and data exploration of social, behavioral and economic phenomena. No experience in spatial analysis required.

Instructors: Arthur Getis (coordinator), John Kaiser, John R. Weeks, Lauren Scott, and Jared Aldstadt (all of San Diego State University) and Michael Goodchild (CSISS, University of California, Santa Barbara).

Host institution: CSISS, University of California, Santa Barbara

Geographically Weighted Regression and Associated Statistics

University of California, Santa Barbara, 4–8 August, 2003; 26–30 July, 2004

Topics covered: Local statistics and local models, the basics of GWR with examples, statistical inference and GWR, GWR and spatial autocorrelation, extensions to the basic GWR framework and concept, applications of specialized GWR software (provided), and visualizing the output in ArcView 3.3.

Instructors: A. Stewart Fotheringham (coordinator), Chris Brunsdon, and Martin Charlton (all of University of Newcastle-upon-Tyne).

Host institution: CSISS, University of California, Santa Barbara

Map Making and Visualization of Spatial Data in the Social Sciences

University of California, Santa Barbara, 23–27 July 2001; 22–26 July 2002

Topics covered: Thematic mapping for the social sciences; principles of scientific visualization; graphical design and cartographic symbolization; geographic visualization; functions and types of maps, use of current graphical design and GIS software (e.g., FreeHand, Photoshop, ArcView); interactive maps for the WWW; mapping statistical data over space and time; and current developments in geographic visualization. No prior experience with visualization software is required.

Instructors: Sara Fabrikant (coordinator), Keith Clarke, and Waldo Tobler (all of University of California, Santa Barbara), Barbara P. Buttenfield (University of Colorado), Mark Gahegan and Frank Hardisty (Pennsylvania State University), Jeremy Crampton (Georgia State University), Wolf-Dieter Rase (Federal Office for Building and Spatial Planning, Germany), and Dan Dorling (University of Leeds).

Host institution: CSISS, University of California, Santa Barbara

Perspectives on Spatial Analysis in the Social Sciences

University of Washington, 19–23 June 2000

Topics covered: Statistical analysis of spatial data, with emphasis on Bayesian and Markov methods (Markov-Chain Monte Carlo).
Instructors: Michael Ward, Julian Besag, and Martina Morris (all of University of Washington).
Host institution: The Center for Statistics and the Social Sciences, University of Washington.

Multiagent Spatial Modeling
University of California, Los Angeles, 24–28 July, 2000
Topics covered: agent-based models of the spatial behavior of autonomous individual decision-makers, cellular automata.
Instructor: Nicholas Gessler
Host institution: Center for Computational Social Science and Social Informatics, University of California, Los Angeles.

Residential Workshops Co-Sponsored by CSISS

ICPSR Summer Workshops
CSISS has encouraged participation in the workshops taught by Luc Anselin (University of Illinois, Urbana-Champaign) for the Interuniversity Consortium on Political and Social Research, and has provided scholarship support.

Introduction to Spatial Data Analysis, 16–20 July, 2001; 24–28 June, 2002; 30 June–3 July, 2003; 14–18 June, 2004
Spatial data visualization and exploration, analysis of clusters and point patterns, global and local indicators of spatial autocorrelation, variogram analysis, and introduction to spatial regression analysis and related software. Familiarity with multivariate statistics and basic concepts of probability theory is expected, and some knowledge of desktop GIS software is required.

Spatial Regression Analysis, 6–10 August, 2001; 5–9 August, 2002; 14–18 July, 2003; 2–6 August, 2004
Spatial econometric analysis, incorporating spatial effects, maximum likelihood and other estimation procedures, specification searches, and implementation in standard software packages. Participant background in intermediate regression analysis or intermediate econometrics, and familiarity with introductory spatial data analysis, is expected.

An Introduction to Spatial Data Analysis with GeoDa, July 25–27, 2005
The workshop is aimed at both new and more experienced users of the GeoDa software for spatial data analysis. It has three main goals: (1) to provide a thorough overview of GeoDa's functionality and how it can be used effectively in a teaching environment; (2) to explain the methodological background behind the software; and (3) to demonstrate how the software can be applied to a range of research questions.

Residential Workshops Funded under Other Programs

SPACE (Spatial Perspectives on Analysis for Curriculum Enhancement)
This program began in late 2003 with funding from NSF's Division of Undergraduate Education under its program for Course, Curriculum, and Laboratory Improvement— National Dissemination (CCLI-ND). SPACE is organized as a program of CSISS, and shares many of its resources. The program exists to achieve systemic change within undergraduate education in the social sciences, with extension to the environmental sciences. Our approach is based on the value of spatial thinking, and associated technologies (geographic information systems and tools for spatial analysis), as the basis for greater integration among the social science disciplines, greater motivation for students, greater relevance to societal problems, greater integration of technology into undergraduate instruction, and greater employment prospects for graduates. SPACE is managed through a consortium consisting of the University of California, Santa Barbara; Ohio State University; and the University Consortium for Geographic Information Science (UCGIS). The SPACE pages of the CSISS website provide further information.

Since the summer of 2004 SPACE has offered six workshops of one- or two-week duration. In 2004 workshops were offered at the University of California, Santa Barbara; Ohio State University; and San Diego State University. In 2005 San Francisco State University was substituted for San Diego State University. More than 120 university instructors completed SPACE workshops in the first two years of the program and 70 more are expected to complete workshops in the summer of 2006.

GIS Population Science program
GIS Population Science program has a primary mission to significantly promote the mastery and use of spatial methods in population research by the current cohort of young population scientists. In support of this mission, the Population Research Institute (The Pennsylvania State University) and the Center for Spatially Integrated Social Science (University of California, Santa Barbara) have combined their expertise to offer national workshops for Ph.D. students, postdocs, and young faculty in demography and in related fields with research interest in population science. In addition, the program is developing Web-based infrastructure for access to learning and research resources by workshop participants and by the broader international community of population scientists.

Two-week-long GIS Population Science workshops were offered in 2005 and will be repeated in 2006 to provide standardized, intensive training for young researchers in geographic information science specifically tailored toward population science. The primary audience for these workshops is interdisciplinary pre-doctoral students of demography at NICHD-supported population training centers in the United States, institutional members of the wider Association of Population Centers (APC), graduate students in demography-related disciplines from both APC and non-APC institutions (including agricultural economics, anthropology, economics, geography, public health, rural sociology, sociology), as well as young faculty and researchers employed in population agencies.

The project is organized under CSISS as a partnership between Penn State and UCSB, and builds on shared expertise in GIS instruction, spatial statistics, and cartographic visualization; shared experience in workshop and conference management; and complementary expertise in demographic science, distance learning, and digital libraries. The GIS Population Science program is funded by the National Institute of Child Health and Human Development (NICHD) as an R25 award titled "GIS Training Program for Population Scientists" (R25 HD047744-01). The support of NICHD is gratefully acknowledged.

Short Workshops and Conferences

Many researchers have participated in CSISS-sponsored events at annual meetings of learned societies—these have included the American Anthropological Association, the Population Association of America, the Regional Science Association, the American Sociological Association, the Rural Sociology Society, the American Agricultural Economics Association, the Southern Demography Association, and the Social Science History Association.

Conference on New Methodologies for the Social Sciences: The Development and Application of Spatial Analysis for Political Methodology, Boulder, CO, March 10–12, 2000. CSISS provided funding for a dozen graduate students to attend from universities across the United States. Two special issues of journals were developed from this meeting: *Political Geography*, "The Development and Application of Spatial Analysis for Political Methodology" (Vol. 21 No. 1, February 2002) and *Political Analysis,* "Spatial Methods in Political Science" (Vol. 10 No. 3, Summer 2002).

More than 80 researchers attended a session on CSISS and opportunities for spatial analysis in criminology at the annual meetings of the **American Society of Criminology** in San Francisco, California, November 16, 2000.

A panel session on the *Center for Spatially Integrated Social Science: A Critical Appraisal* was organized at the annual meetings of the **Association of American Geographers** in New York in March 2001.

CSISS was a co-sponsor with Florida International University (Center for Transnational and Comparative Studies) of a **Workshop on Political Processes and Spatial Analysis**, which met in Miami, Florida, 5–6 March 2001. CSISS provided travel support for graduate students attending the conference. The participants were largely from political science and geography.

With ICPSR, CSISS co-sponsored the **Advanced Workshop on Spatial Analysis in Social Research**, held at the University of Michigan, 17–20 May 2001. The workshop brought together leading methodologists in spatial analysis from across the social sciences to explore the transfer of new analytic technologies among mainstream social sciences.

CSISS was invited to present a half-day workshop at the Annual Meeting of the **American Sociological Association** in Anaheim in August 2001. Presentations covered issues in mapping social data, uses of GIS and spatial statistics, advances in cartographic representation, and CSISS programs. About 25 registered participants took part in the workshop, consisting of mostly professors of sociology and demography, and graduate students.

The Wharton GIS Lab (The Wharton School, University of Pennsylvania) and CSISS co-sponsored a 3-day workshop on **Spatial Data Analysis in the Social Sciences**, in Philadelphia, August 29–31, 2001. Michael Goodchild and Luc Anselin joined Susan Wachter, Ayse Can Talen, and Paul Amos as instructors.

A two-day **Workshop on Agent-Based Models of Land Use / Land Cover Change** was organized in Irvine, CA, October 6–7, 2001, in conjunction with the National Academy of Science's **Sackler Colloquium on Adaptive Agents, Intelligence & Emergent Human Organization: Capturing Complexity Through Agent-Based Modeling**. More than twenty papers and presentations were prepared for this workshop. They were posted on the events page of the CSISS website and provided the foundation for a special CSISS resource center and listserv for researchers from around the world.

CSISS participated as contributing sponsor to a very successful conference in Chicago (November 2001) on **Digital Communities 2001**. The Conference, which attracted nearly 150 participants from a broad range of disciplines from nearly two dozen countries, was organized by the Department of Communications Studies at Northwestern University, e-Tropolis Evanston, and E-Space (the Electronic Space Project at Michigan State University). Six graduate students were supported with CSISS travel awards to present their research at the conference. Don Janelle, CSISS Program Director, was on the Advisory Board for the conference; both he and Helen Couclelis (CSISS Researcher) gave presentations.

A panel on spatial social science organized by CSISS at the annual meetings of the **Association of American Geographers** in Los Angeles, March 22, 2002, explored the meaning of spatially integrated social science, new tools for spatial analysis, Web infrastructure for spatial social science, the discipline penetration of CSISS workshops, and the diffusion of spatial thinking in the social sciences.

Short Course on the Economics of Urban Sprawl. CSISS co-sponsored with the UCSB Economics Department and the Bren School a one-day Workshop on Urban Sprawl and Land Use Change. CSISS Scholarship support was provided for a dozen graduate students. The workshop preceded the World Congress of Environmental and Resource Economists (Monterey, 24–26 June 2002). Michael Goodchild and Keith Clarke demonstrated the application of GIS and spatial analysis tools in providing perspective on sprawl.

CSISS hosted a two-day meeting of the **International DDI (Data Documentation Initiative) Geography Working Group** at UCSB in August 2002. The purpose was to

extend the metadata standards for social science data to include metadata for spatial data. August 2002.

CSISS sponsored the participation in September 2002 of Michael Goodchild and Raymond Wong (Sociology, UCSB) in a research workshop with representatives from the **National Center for Violence Research (NCOVR)** in Irvine, California. The purpose was to explore possible common research and infrastructure initiatives between CSISS and NCOVR.

CSISS sponsored the participation of Dr. John R. Logan in a special workshop at Ohio State University in September 2002 as part of an initiative of the **American Sociological Association** to promote spatial perspectives in sociological research.

A half-day workshop on spatial analysis in anthropology at the annual meetings of the **American Anthropological Association** in New Orleans, LA, November 20–24, 2002, organized by Barbara Herr-Harthorn (UCSB) and Emilio Moran (Indiana University), attracted more than 70 participants. Moran introduced spatial approaches in anthropological research, Eduardo Brondizio (Indiana) reviewed applications of spatial and temporal analysis in ethnographic research, Luc Anselin (Illinois) discussed mapping and analysis in the social sciences, Don Janelle reviewed resources for spatial thinking and analysis, and Susan Stonich (UCSB) explored "The Future of Spatial Approaches in Anthropology." The workshop was followed by a paper session on *Powerful GIS Tools to Advance Spatial and Temporal Analysis in Anthropological Research.*

CSISS organized a workshop "Spatial Analysis for Rural Sociology and Agricultural Economics" at the annual meetings of the **American Agricultural Economics Association** and the **Rural Sociological Society**, Montreal, Quebec, July 26, 2003. This half-day workshop attracted more than 70 participants. Its objective was to facilitate a more explicit recognition of spatial effects in the analysis of geo-referenced data within the research domains of rural sociology and agricultural economics. It featured presentations on spatial tools for econometric and exploratory analysis (Goodchild), CSISS resources for research and teaching (Janelle), exploiting space in agricultural economic models (Gerald Nelson, UIUC), and spatial analysis in rural sociology (Paul Voss, U Wisconsin – Madison).

A workshop titled "Does Space Matter? Analyzing and Visualizing Spatial Effects in Sociology" was organized by CSISS at the annual meetings of the **American Sociological Association**, Atlanta, GA, August 17, 2003. It addressed (1) the theoretical rationale for including spatial perspectives in sociological research, (2) the availability of spatial data and spatial-analytic tools for studying social patterns and processes, and (3) the integration of spatial statistics with methods of spatial visualization. Instructors demonstrated new software tools and illustrated how the spatial perspective adds substantive insights to research in areas of neighborhood and regional analysis of population, crime, health, and communication. More than 50 people participated in the session.

Workshop Application and Participation Patterns

Table 1 shows the numbers of applicants and attendees in each of the five years of NSF-funded workshops, aggregated by discipline. There was a steady increase in the number of applicants through 2003, by which point places in CSISS workshops were oversubscribed by a factor of 3.5. In 2004 CSISS reduced the number of available workshops to two and was unable to offer scholarship support for participants, although no fees were charged. As a result the ratio of oversubscription fell to 2.0. In all years, interest in spatial analysis workshops among social scientists exceeded capacity by a significant margin. CSISS was able to serve 49% of applicants in 2000, 43% in 2001, 31% in 2002, 28% in 2003, and 49% in 2004.

Table 1. Numbers of Applicants and Attendees in CSISS Summer Workshops

Discipline	ATTENDEES						APPLICANTS						Ratio
	2000	2001	2002	2003	2004	**Totals**	2000	2001	2002	2003	2004	**Totals**	**Ratio**
Economics	9	12	7	7	6	**41**	10	45	21	25	15	**116**	**0.35**
Political Science	14	5	4	9	3	**35**	26	12	7	13	4	**62**	**0.56**
Sociology	11	13	9	11	3	**47**	14	31	22	18	9	**94**	**0.50**
Anthro	5	12	10	6	2	**35**	10	32	25	15	3	**85**	**0.41**
Geography	17	20	22	20	9	**88**	46	61	73	110	26	**316**	**0.28**
Public Policy	2	8	4	1	0	**15**	9	23	25	21	0	**78**	**0.19**
Urban Studies/Plan	3	6	3	8	6	**26**	6	11	10	48	10	**85**	**0.31**
Statistics	3	2	0	2	0	**7**	4	4	0	5	2	**15**	**0.47**
Criminology	3	6	3	1	1	**14**	4	10	7	6	2	**29**	**0.48**
Population/ Health	1	12	6	24	13	**56**	2	18	22	61	15	**118**	**0.47**
Other	4	7	4	4	1	**20**	21	15	12	6	4	**58**	**0.34**
	72	103	72	93	44	**384**	152	262	224	328	90	**1056**	**0.36**

Applicants were selected on several factors:

- The need to maintain a broad mix of disciplines, creating groups of participants who were as far as possible representative of the full spectrum of the social sciences.
- A desire to populate workshops with diverse mixes of gender, ethnicity, and regional background in addition to discipline, and to maximize representation by traditionally under-represented groups.

- The need to achieve a good fit between the expectations of the instructors and the experience and abilities of the participants.

Table 1 reveals a broad disciplinary representation. While geography is the most strongly represented, this representation has declined as a proportion of all participants. The increase in population and demography in 2003 reflects the specialized workshop in this area at Pennsylvania State University.

The percentage of women participants ranged between 40% and 50%, and did not vary significantly by year or by workshop topic.

Survey of Participants in CSISS Programs

In March 2003, the UCSB Social Science Survey Research Center administered a Web-based survey of all applicants/participants for CSISS programs, including both specialist meetings and workshops. Responses on a few questions are especially useful in evaluating the success of the workshop and specialist meeting programs. The survey targeted 518 participants and 223 non-participant applicants to CSISS programs since January 2000. Excluding email bounces of approximately 20%, the response rate was 55 percent—this included 232 participants and 92 non-participants. Some responses follow:

- 87% of participants "**strongly agree" or "agree"** that **"My CSISS experience has had positive impacts on my research"**
- 57% of participants **"strongly agree" or "agree"** that **"CSISS experience has had positive impacts on my teaching"**

Full details on the survey provide cross-tabulations by discipline, status of participant (e.g., graduate student / tenured professor), and level of expertise in spatial analysis. A full report on this survey is available at http://www.csiss.org/survey.

III. Best Examples

Spatially Integrated Social Science

Edited by Michael Goodchild and Donald Janelle, this book was published by Oxford University Press in early 2004. Indications are that it has been well received, though no published reviews are yet available.

In identifying contributors, we looked for authors of articles with relevant content who were widely cited, supported from major peer-reviewed funding programs, and noted for use of spatial approaches within their disciplines. Though the authors represent several disciplines, they have one major attribute in common—the application of spatial thinking in their research designs and execution.

The book illustrates how the spatial perspective adds value and insight to social science research, beyond what traditional non-spatial approaches might reveal, and makes available outstanding examples on the uses of spatial thinking. 21 chapters illustrate how spatial analysis fosters theoretical understanding and empirical testing. Each chapter exemplifies the founding principle for CSISS—that the analysis of social phenomena in space and time enhances our understanding of social processes. The chapters offer substantive empirical content for illustrating the interpretation of specific spatial analytic approaches suited to advanced research in the social sciences. It is our hope that the book will help cultivate an integrated approach to social science research that recognizes the importance of location, space, spatiality, and place. Aside from demonstrating applications of spatial analysis in research, it is anticipated that this book will also be suited as an advanced-level text for a trans-disciplinary audience.

A special Web page, http://csiss.ncgia.ucsb.edu/best-practices/siss/, provides the table of contents, abstracts of each chapter, access to graphics and tables featured in the book, and supplementary resources contributed by the authors.

Advances in Spatial Econometric Modeling: Methodology, Tools and Applications

A second CSISS Best Practice book was published in 2004 by Springer-Verlag. The editors are Raymond Florax (Free University Amsterdam), Sergio Rey (San Diego State University), and Luc Anselin (University of Illinois, Urbana-Champaign). It includes papers by many leading researchers in spatial econometrics, and should have a significant impact on the use of spatial perspectives in economics.

Table of Contents

Preface
Michael F. Goodchild
1. Econometrics for Spatial Models: Recent Advances
    Luc Anselin, Raymond J.G.M. Florax, Sergio J. Rey

Elena Irwin, Nancy Bockstael

Part IV. Trade and Economic Growth

17. **Does Trade Liberalization Cause a Race-to-the-Bottom in Environmental Policies? A Spatial Econometric Analysis**
    Paavo Eliste, Per G. Fredriksson
18. **Regional Economic Growth and Convergence: Insights from a Spatial Econometric Perspective**
    Bernard Fingleton
19. **External Effects and Cost of Production**
    Rosina Moreno, Enrique Lopez-Bazo, Esther Vaya, Manuel Artýs
20. **Growth and Externalities Across Economies: An Empirical Analysis Using Spatial Econometrics**
    Esther Vaya, Enrique Lopez-Bazo, Rosina Moreno, Jordi Surinach

CSISS Classics

Another initiative, CSISS Classics, supplements the book series with a Web presence. It is simultaneously part of the Learning Resources program. This short descriptive statement of intent appears on the website:

> The foundations of spatial analysis span many disciplines over many generations of researchers and practitioners. CSISS Classics provides summaries and illustrations of major contributions to spatial thinking in the social sciences. Primary emphasis is given to research before 1980, with an attempt to capture and acknowledge the repository of spatial thinking in the social sciences for the last few centuries. The summaries, along with key references, are intended as guides for those interested in exploring intellectual inheritance from previous generations.

Currently, there are nearly 50 items in the collection and more are under development. In 2002 a user comment feature was added to each selection. Since then we have received numerous responses and suggestions. CSISS Classics are the biggest draw to the website, accounting for more than 270,000 visits to www.csiss.org between 16 November 2003 and 20 August 2004.

IV. Software Tools

Under the direction of Dr. Luc Anselin, CSISS researchers at the University of Illinois at Urbana-Champaign (UIUC) have developed and disseminated a powerful and easy-to-use suite of software for spatial data analysis, advanced methods of statistical analysis to account for spatial effects, and integrated these developments with GIS capabilities.

Objectives

The objectives of the software tools program of CSISS were to disseminate and develop software to enable the analysis of spatial data, to facilitate the incorporation of spatial effects such as spatial autocorrelation and spatial heterogeneity in empirical analysis, and to promote state-of-the-art methods for spatial econometric analysis in the social sciences. As such, the activities carried out under this program consist of software dissemination as well as software development and methodological development.

Summary

During the five years of the project, the software tools initiative has evolved from an emphasis on providing support materials and Web resources through a clearinghouse to a major effort to develop, release, and support a number of easy-to-use software tools for spatial data analysis. First and foremost among these is the *GeoDa* package, first released in February 2003 and rapidly becoming a standard for introductory spatial data analysis, with close to 8,500 registered unique downloads as of November 2005.

During this period, the project was housed in different locations, initially as part of the Regional Economics Applications Laboratory (REAL) at UIUC, and, since Summer 2002, in the Spatial Analysis Laboratory directed by Anselin, which currently occupies a separate laboratory space in the Department of Geography at UIUC.

The main accomplishments of the project are:

- The establishment of a Web-based clearinghouse devoted to software tools for spatial data analysis (http://www.csiss.org/clearinghouse/), including a specialized search engine, a collection of links to selected tools, and links to portals containing related collections of software tools.
- The establishment of a website containing supporting materials, tutorials, sample data sets, and CSISS-developed sample software for spatial data analysis (http://sal.uiuc.edu/stuff_main.php).
- Support for the geographical components of the open-source R statistical software package, through maintenance of the Rgeo website (http://sal.uiuc.edu/csiss/Rgeo) and code contribution.
- The establishment of a website devoted to the *GeoDa* software package, including a software download site, documentation, and support materials (http://geoda.uiuc.edu).

- The establishment and maintenance of a mailing list to support a global internet community interested in spatial data analysis in general and focused on technical support for *GeoDa* in particular (http://sal.uiuc.edu/mailman/listinfo/openspace).
- The organization of a Specialist Meeting devoted to Spatial Data Analysis Software Tools (Santa Barbara, CA, May 10–13, 2002), resulting in a special issue of the journal *Geographical Analysis* [(2006) 38(1)].
- The development and release of software for spatial data analysis:
  - *GeoDa*, a freestanding software package for spatial data analysis, written in C++ and using the ESRI MapObjects library for mapping, released Feb. 2003.
  - *OpenGeoDa*, a cross-platform (Windows, Linux, and Mac OS X) and open-source version of *GeoDa*, written in C++ and based on the open-source wxWidgets cross-platform GUI library, slated for release in December 2005.
  - Webtools, open-source Java code (beans and applets) for spatial data analysis, released in January 2003, including rate smoothing, outlier detection, and spatial autocorrelation analysis, now included in the GeoVISTA Studio program maintained at Pennsylvania State University (available from sourceforge.net), and implemented at http://sal.uiuc.edu/geotools_main.php as a Web-based analysis interface.
  - PySAL and PySpace, a collection of open-source and cross-platform modules for spatial data analysis and spatial econometrics, written in the Python language (http://sal.uiuc.edu/projects_pysal.php).
  - Routines dealing with spatial regression contributed to the spdep package of the R statistical environment (maintained by Roger Bivand, Bergen University).
  - Contributions to the development of spatial regression routines in the National Institute of Justice (NIJ) CrimeStat package (Ned Levine).
- Development of supporting materials, including some 40 sample data sets, a website with spatial weights matrices, a help system, tutorials, and exercise workbooks for *GeoDa*, tutorials for spatial regression in R, point pattern analysis in CrimeStat, and variography in Variowin.
- Methodological advances related to geovisualization, spatial autocorrelation analysis, and maximum-likelihood spatial regression applied in very large data sets, including a new parallel algorithm and a solution to compute the asymptotic variance matrix.
- Publication of results through three edited journal special issues, one edited book, one edited proceedings volume, as well as 18 journal articles (published and forthcoming), six book chapters, three conference proceedings articles, and 13 software manuals/tutorials.
- Dissemination of results at 46 presentations (not including CSISS Specialist Meetings and Workshops), of which 19 were directly related to *GeoDa*, including six multiple-day short courses and four one-day workshops.

Each of these items will be described in some detail in what follows.

Web Resources

The software tools clearinghouse

The software tools clearinghouse is intended to complement CSISS's own software development efforts with a comprehensive collection of links to software developed by others, in both the private and public sector (including academics).

The clearinghouse was launched in October 2001 as part of the CSISS website and consists of three main entry points:

- a spatial tools search engine,
  http://www.csiss.org/cgi-bin/texis/webinator/clearsearch;
- a collection of links to portals,
  http://www.csiss.org/clearinghouse/links.php3; and
- a collection of links to specific software sites (select tools),
  http://www.csiss.org/clearinghouse/select-tools.php3.

In addition, a fourth entry point, links to the CSISS materials on the SAL (Spatial Analysis Laboratory, UIUC) website.

The *Spatial Tools Search Engine* is a specialized search engine built on a database of selected links and websites dealing with a software tools and methods for spatial data analysis. The database has been custom-designed to optimize the efficiency of the search engine with respect to the specialized materials of spatial data analysis. Therefore, the search engine is more effective with respect to these topics than a general-purpose Internet search engine. This specialized search engine complements the generic spatial analysis search engine on the CSISS site. It continues to be updated and refined in response to user feedback.

The *Links to Portals* are entry points to specialized portals dealing with spatial statistics in particular and spatial analysis in general. These are well-established portals developed by individuals, university departments and laboratories, and professional societies. Rather than duplicating these portal efforts, a decision was made to build a collection of links to existing sites. The set of links continues to be updated and refined in response to user feedback.

The *Select Tools* are a collection of links to specialized sites that contain software for spatial data analysis. Some of these sites are commercial, but several are academic sites containing customized software tools (some freestanding, some as add-ons, scripts, or extensions of commercial tools). All the sites contained in the list have been checked for appropriateness. As with the other links, the set continues to be updated and refined in response to user feedback.

The CSISS Tools link connects to http://sal.uiuc.edu/projects_csiss.php on the SAL server the University of Illinois, Urbana-Champaign.

The CSISS materials at UIUC

At UIUC, the CSISS tools and related materials are available from the website of the Spatial Analysis Laboratory (http://sal.uiuc.edu), initially launched in January 2003. In addition, since March 2005, there is a separate site devoted solely to *GeoDa* (http://geoda.uiuc.edu). The *GeoDa* site is run as a secure server to protect the privacy of users downloading the software.

Both sites have undergone multiple changes since their inception. They are currently run off a Linux virtual server maintained by the computer support staff of the College of Liberal Arts and Sciences at UIUC (ATLAS). In addition, a development server running off an Apple dual G5 under Mac OS X is maintained in the SAL laboratory (http://sal-dev.sal.uiuc.edu) to prototype Web-based materials and software. Currently (November 2005), the SAL and *GeoDa* sites are being ported to the open source plone (http://plone.org) environment to facilitate more flexible content management.

The SAL site contains links to the CSISS site, to the Openspace mailing list, to the two main software projects (*GeoDa* and PySpace), and to the R-Geo website, supporting the spatial analysis capability of the R open source statistical programming environment. A direct link to the R-Geo site is also available from the main Comprehensive R Archive Network (CRAN) R projects site (http://www.r-project.org/). In addition, the SAL site contains links to supporting materials, which are described below.

The *GeoDa* site contains the software downloads pages, and links to manuals, tutorials, publications and presentations, as well as to the SAL data set repository. In addition, it includes a news page, which lists information on user numbers, their geographic distribution, the use of *GeoDa* in the classroom and lab, and quotes from users. Links for support provide an easy way to subscribe to the openspace mailing list. The site also includes announcements of *GeoDa* workshops and training sessions.

The SAL and *GeoDa* sites continue to be visited with high frequency, averaging visits by around 7,000 unique IP addresses per month during the past year (Dec 04-Nov 05), roughly divided as 85% for the SAL site and 15% for the *GeoDa* site.

The Openspace Mailing List

The openspace mailing list (openspace@sal.uiuc.edu) was launched in Spring 2003 to promote the discussion of open source development of spatial software tools and to support the CSISS software products (primarily *GeoDa*). From an initial number of subscribers of 69 in May 2003, the membership has constantly grown to a total of more than 700 individuals in Nov. 2005. It has exceeded 600 members for more than a year and is now stable, with very little attrition. In March 2005, the list was moved to a new server, maintained by the ATLAS staff at UIUC, with little impact on postings or subscribers.

The list includes an archive of previous postings, organized by date or thread.

Specialist Meeting

A Specialist Meeting on Spatial Data Analysis Software Tools was held at the Upham Hotel in Santa Barbara, CA, 10-13 May 2002. A detailed report is provided elsewhere.

Software Development

The software development effort has consisted of three main activities, each carried out in different programming environments. Most important among these was the development of an easy to use program for spatial data analysis, *GeoDa*, and its cross platform open source successor, *OpenGeoDa*, both written in C++. A second important activity was the development of a collection of routines to deal with spatial data analysis and spatial econometrics, written in the open source Python language and combined in the PySAL library, with different front ends (including PySpace and STARS). Both activities are ongoing.

A third activity consisted of the development of Java beans and applets incorporating spatial data analytic functionality. These have been incorporated into the GeoVISTA Studio program, maintained at Pennsylvania State University. They have also been implemented in a Web interface, accessible on the SAL website at http://sal.uiuc.edu/geotools_main.php. This activity has come to a close.

In addition, miscellaneous software-development activities have included the creation of functions in the open-source R statistical-software environment to deal with spatial regression, resulting in contributions to the R spdep package. Early on in the project, prototypes of spatial-regression functions were also developed in the XlispStat package, but this was discontinued and replaced by the use of R and Python. Finally, some assistance was provided to Ned Levine in the development of spatial-regression routines for the CrimeStat package, developed under the auspices of the National Institute of Justice.

GeoDa

GeoDa, the *Geodata Analysis software*, is the successor to and a replacement for DynESDA2 and the DynESDA extension for ESRI's ArcView 3.x GIS. It is a freestanding program, built on ESRI's MapObjects LT2 technology, using the shapefile format as the standard for storing spatial information. GeoDa version 0.9 (beta) was released on 5 February 2003, with two major updates, version 0.9.3, released in June 2003, and version 0.9.5-i, released in January 2004. A major bug fix (version 0.9.5i_6) was released in August 2004. A complete HTML-based help system was added in November 2005.

GeoDa consists of a user-friendly interactive (point and click) environment that combines maps with statistical graphics, using the technology of dynamically linked windows. Besides its mapping functionality (including smoothers for rate maps) the first version also contained the usual EDA graphs (histogram, box plot, scatterplot) and implemented *brushing* for both maps and statistical plots. Maps can be constructed for points as well as

polygons, and tools are provided to create one from the other (centroid computation, Thiessen polygons), as well as to construct various types of spatial weights. In addition, GeoDa contains functionality for spatial autocorrelation analysis, in the form of a Moran scatterplot and LISA maps, both univariate as well as bivariate.

GeoDa updates added functionality for enhanced data manipulation and table calculations, refined LISA maps, Empirical Bayes corrected spatial-autocorrelation analysis for rates, cartograms, conditional maps, parallel-coordinate plots, 3D visualization, as well as the basics of spatial-regression analysis. A complete list of features can be found at http://geoda.uiuc.edu/features.php.

A technical discussion of the functionality of GeoDa is contained in the forthcoming article by L. Anselin, I. Syabri, and Y. Kho [(2006) GeoDa, an introduction to spatial data analysis, *Geographical Analysis* 38(1)]. A Quicktime movie illustrating its main features is available at https://www.geoda.uiuc.edu/movies/GeoDaDemo.mov.

GeoDa is free and can be downloaded from a secure website at https://www.geoda.uiuc.edu/downloadin.php. It comes with an installation program, User's Guide, and sample data sets.

The adoption of GeoDa has been nothing short of phenomenal. Initial unique downloads (unique registered e-mail address, not counting multiple downloads by the same e-mail address) amounted to 300 in April 2003, growing to 900 in November 2003, 2000 in May 2004, 4000 in December 2004, and approaching 8500 in November 2005. In addition, some 500 CD-ROMs containing the GeoDa code and supporting materials have been distributed at various conferences and workshops, and 600 lab seats registered. GeoDa's user base is truly international, including users in more than 60 countries.

GeoDa is increasingly used in the classroom and has laboratory installations at over 30 institutions (a partial list is given in the following table). Samples of classroom use are listed at https://www.geoda.uiuc.edu/news.php#class.

Institution
Cornell University
Harvard University
Hobart and William Smith Colleges
Institut Teknologi Bandung
Iowa State University
Massachusetts Institute of Technology
Mississippi State University
Mount Holyoke College
Norges Handelshøyskole
Northeastern Illinois University
Ohio State University
Penn State University
Purdue University
Southern Illinois University at Carbondale
Temple University
Tufts University

Universidad Autónoma de Madrid
Universite Montesquieu-Bordeaux IV
University at Albany
University of California, Irvine
University of California, Santa Barbara
University of Canterbury
University of Colorado, Boulder
University of Illinois, Urbana-Champaign
University of Kansas
University of Michigan
University of North Carolina
University of Wisconsin - Madison
University of Pennsylvania
Chinese Academy of Sciences (CCAP)

Table 2: Partial List of Institutions with a GeoDa Laboratory Installation (20 seats minimum).

OpenGeoDa

OpenGeoDa is a port of GeoDa to an open-source and cross-platform version that runs identically on Windows, Linux, and Mac OS X. It is written in C++ and contains over 80,000 lines of code (not including resource files). OpenGeoDa utilizes the C++ wxWidgets cross-platform graphical user interface library (http://www.wxwidgets.org/). In the process of porting, most mapping routines were rewritten from scratch and a major restructuring of the program organization was carried out.

The functionality of OpenGeoDa 1.0 (slated for release in December 2005) is nearly identical to that of GeoDa 0.9.5-i, with some notable improvements. There are additional map legend classifications (including unique-value maps), use of general spatial weights (no longer only contiguity weights), bivariate maps (choropleth map, cartogram, and map movie) and various minor fixes and enhancements.

OpenGeoDa is in the process of being set up as a sourceforge.net project (November 2005) and will be fully open source, released under a GPL license. In addition to the source-code files (with make files for compilation on different platforms), binaries will be available for Windows and Mac OS X.

PySpace and PySAL

PySpace is an open-source development effort to create a collection of object-oriented modules that implement cross-platform functionality for spatial statistics and spatial econometrics. To date, this has yielded various prototype modules, including functionality for spatial regression and spatial-regression diagnostics, spatial panel regression, space–time visualization, mapping, rate smoothing, global and local spatial autocorrelation statistics, and exploratory analysis of flows. A presentation on the panel spatial regression tools was made by L. Anselin and J. LeGallo at the 2004 Annual Meetings of AAG (March 2004).

A small number of modules have been implemented in a graphical environment, using the wxPython tools (http://www.wxpython.org/). This includes mapping, rate smoothing, and spatial autocorrelation analysis. An earlier graphical interface was based on Tkinter and included functionality to visualize space–time patterns of local association and outliers in a realistic three-dimensional rendering of a landscape. This involved the combination of functionality from MySQL (the database containing the space–time data) and Vtk (the visualization toolkit) with Python code to compute outliers and locations with significant local spatial autocorrelation. The result is an interactive "movie" that allows the analyst to browse through data for 1095 daily observations for 400 cross-sectional units. The tool was applied to an analysis of the effect of air quality on respiratory disease in the Los Angeles basin (funded in part by an NSF/EPA grant). The tool was demonstrated and included in presentations at the Allied Social Science Associations meetings in Washington, DC (January 2003), as well as at departmental seminars at the University of Texas, Dallas, the University of Illinois, and the University of Wisconsin.

In Summer 2004, Anselin and Dr. Sergio Rey (San Diego State University) agreed to integrate their Python-based software development efforts and create a library of Python modules for spatial analysis, PySAL. This institutes a formal merger of the functionality in PySpace and in STARS (http://stars-py.sourceforge.net/), putting their ongoing collaboration in a more organized software-development framework. The library will cover a range of core spatial-data-analytical functions, allowing different graphical user interfaces as front ends. Initial functionality includes interfaces with various data sources (including ESRI shapefiles), the construction and manipulation of spatial weights, a computational geometry core, EDA and ESDA, clustering, and basic spatial regression. The project is in the process of being organized on sourceforge.net with an initial (partial) release slated for early 2006. Presentations on the objectives, design, and architecture of PySAL were made by Anselin and Rey at the 2005 AAG Annual Meetings (April 2005) and GeoComputation 2005 (August 2005).

Development of the PySAL library is ongoing, including the connection of the library to various graphical user interface frontends.

Webtools

An initial effort in the software tools program was to develop a collection of open-source Java applets (for use with a Web browser) and applications (for freestanding use) to implement exploratory spatial data analysis and spatial regression.

A prototype spatial-regression Java application was developed as a working prototype. It implements diagnostics for spatial correlation in linear regression models, as well as the estimation of both spatial-lag and spatial-error models by means of a variety of approaches (maximum likelihood, instrumental variables). Its further development was abandoned in December 2003 due to lack of performance and a refocus on the use of Python as the preferred development environment.

A collection of Java applets implement spatial data analysis in a Web environment, and was made available in January 2003 on the SAL website. It can currently be accessed at http://sal.uiuc.edu/geotools_main.php. The applets are developed by extending the Geotools open-source mapping toolkit. Functionality includes specialized mapping of outliers (box maps), rate-map smoothing, and spatial-correlation analysis by means of a Moran scatterplot. These methods can be applied to six sample data sets: Anselin's Columbus crime data, Cressie's North Carolina SIDS data, and county-level homicide data for three time periods for the U.S. as a whole, and for counties surrounding St. Louis, Atlanta, and Houston (the latter four data sets were part of an Atlas of U.S. homicides, developed as part of an NCOVR funded project).

The same functionality was also implemented as Java Beans and included in the GeoVISTA Studio environment, available from sourceforge.net.

Technical details on the webtools were presented at the GIScience 2002 Conference in Boulder, CO (September 2002) and are contained in a published paper [L. Anselin, Y-W Kim, and I. Syabri (2004) Web-based spatial analysis tools for the exploration of spatial data. *Journal of Geographical Systems* 6(2): 197–218].

Development of tools in Java has been discontinued. All existing functionality has been ported to Python modules and included in the PySAL library.

Supporting Materials

A collection of supporting materials is available at http://sal.uiuc.edu/stuff_main.php. This includes a set of tutorials, a sample data set repository, an interactive website to create spatial weights files, and several Powerpoint presentations available as downloadable pdf files. The sample data repository is at http://sal.uiuc.edu/data_main.php and contains 39 data sets in ESRI shapefile format (with two more slated to be added in November 2005). These data sets include several classic textbook examples, such as the Columbus neighborhoods, the SIDS data for North Carolina counties, the Boston air pollution data, the Ohio lung and Scottish lip cancer data, as well as other data sets that allow the replication of published studies.

At http://sal.uiuc.edu/weights, an interactive user interface is available to select and download spatial-weights files for the contiguity structure among counties in each state of the U.S., for the U.S. as a whole, and for the U.S. states. The interface was implemented in Python and runs on the server, requiring only a browser to access the program.

A complete list of tutorials and other support materials is given below. They are available as downloadable pdf files on the server.

GeoDa support materials

- L. Anselin, *GeoDa 0.9 User's Guide*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and

Consumer Economics, University of Illinois, Urbana-Champaign, revised June 2003 (126 pp.).

- L. Anselin, *An Introduction to EDA with GeoDa*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, June 2003 (21 pp.).
- L. Anselin, *An Introduction to Spatial Autocorrelation Analysis with GeoDa*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, June 2003 (20 pp.).
- L. Anselin, *GeoDa 0.9.5-i Release Notes*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, January 2004 (64 pp.).
- L. Anselin and J. Koschinsky, *Demo for Teaching: Spatial Autocorrelation*, Dec. 2004 (3 pp.).
- L. Anselin, *Exploring Spatial Data with GeoDa: A Workbook*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Geography, University of Illinois, Urbana-Champaign, revised March 2005 (244 pp.).
- J. Koschinsky, *GeoDa Help System* (HTML), revised Nov. 2005 (100 pp.).

Other tools-related support materials

- L. Anselin, *An Introduction to Spatial Regression Analysis in R*. Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, May 2003 (25 pp.).
- L. Anselin, *An Introduction to Point Pattern Analysis using CrimeStat*. Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, June 2003 (19 pp.).
- L. Anselin, *An Introduction to Variography using Variowin*. Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, June 2003 (17 pp.).
- L. Anselin, *Data and Spatial Weights in spdep, Notes and Illustrations*. Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, July 2003 (19 pp.).
- L. Anselin, *Web-Based ESDA Tutorial*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, revised May 2004 (11 pp.).
- L. Anselin, *Spatial Regression Analysis in R, A Workbook*, Spatial Analysis Laboratory and Center for Spatially Integrated Social Science (CSISS), Department

of Agricultural and Consumer Economics, University of Illinois, Urbana-Champaign, Jan. 2005 (90 pp.).

Methodological Advances

An increasingly common impediment to the application of spatial-regression analysis is the size of the data set. The standard, eigenvalue-based method to implement maximum-likelihood estimation for spatial-lag and spatial-error models breaks down for data sets with more than 1,000 observations. A small number of alternatives have been suggested in the literature, but few work effectively for data sets with more than 1 million observations. A method based on characteristic values, recently suggested by Smirnov and Anselin [(2001) *Computational Statistics and Data Analysis*] was implemented in C++ to remove this impediment and included in the *GeoDa* release of June 2003.

A remaining problem was the computation of the asymptotic variance matrix, which involves the inverse of a non-sparse matrix of dimension equal to the size of the data set (e.g., a 1 million by 1 million matrix). Smirnov developed a new approach that approximates the solution with an acceptable degree of precision and within reasonable computation time. Technical details are provided by O. Smirnov [(2006) Computation of the information matrix for models of spatial interactions. *Journal of Computational and Graphical Statistics*]. The new algorithm has also been implemented as C++ code and included in the *GeoDa* release of June 2003.

Further research on the computational aspects of large spatial regressions has focused on parallel methods, as outlined in a working paper by O. Smirnov and L. Anselin [A parallel method for maximum likelihood estimation of models with spatial dependence. Presented at the 50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003].

Methodological advances have also been made in the visualization of bivariate spatial autocorrelation, space-time correlation, and 3D visualization of spatial patterns. These have been reported in a number of working papers.

Dissemination

Journal special issues

L. Anselin, guest editor (2000) Special Issue on Computing Environments for Spatial Data Analysis. *Journal of Geographical Systems* 2(3).

L. Anselin, guest editor (2003) Special Issue on Spatial Externalities. *International Regional Science Review* 26(2).

S. Rey and L. Anselin, guest editors (2006) Special Issue on Software for Spatial Analysis in the Social Sciences. *Geographical Analysis* 38(1).

Edited volumes

L. Anselin and S. Rey, editors (2002) *New Tools for Spatial Data Analysis: Proceedings of a Workshop*. Center for Spatially Integrated Social Science, University of California, Santa Barbara (CD-ROM).

L. Anselin, R. Florax, and S. Rey, editors, (2004) *Advances in Spatial Econometrics. Methodology, Tools and Applications.* Berlin: Springer-Verlag.

Refereed journal articles

L. Anselin (2000) Computing environments for spatial data analysis. *Journal of Geographical Systems* 2(3): 201–225.

L. Anselin (2001) Spatial effects in econometric practice in environmental and resource economics. *American Journal of Agricultural Economics* 83(3): 705–710.

R. Baller, L. Anselin, S. Messner, G. Deane, and D. Hawkins (2001) Structural covariates of U.S. county homicide rates, incorporating spatial effects. *Criminology* 39(3): 201–232.

R. Baller, S. Messner, L. Anselin, and G. Deane (2002) The interchangeability of homicide data sources: a spatial analytical perspective. *Homicide Studies* 6(3): 211–227.

L. Anselin and W. Tam Cho (2002) Spatial effects and ecological inference. *Political Analysis* 10(3): 276–297.

L. Anselin and W. Tam Cho (2002) Conceptualizing space. *Political Analysis* 10(3): 301–303.

L. Anselin (2002) Under the hood: issues in the specification and interpretation of spatial regression models. *Agricultural Economics* 17(3): 247–267.

L. Anselin (2003) Spatial externalities. *International Regional Science Review* 26(2): 147–152.

L. Anselin (2003) Spatial externalities, spatial multipliers and spatial econometrics. *International Regional Science Review* 26(2): 153–166.

L. Anselin and R. Moreno (2003) Properties of tests for spatial error components. *Regional Science and Urban Economics* 33(5): 596–618.

L. Anselin, R. Bongiovanni, and J. Lowenberg-DeBoer (2004) A spatial econometric approach to the economics of site-specific nitrogen management in corn production. *American Journal of Agricultural Economics* 86(3): 675–687.

L. Anselin, Y-W Kim, and I. Syabri (2004) Web-based spatial analysis tools for the exploration of spatial data. *Journal of Geographical Systems* 6(2): 197–218.

L. Anselin (2006) How (not) to lie with spatial statistics. *American Journal of Preventive Medicine*.

L Anselin, I. Syabri, and Y. Kho (2006) GeoDa: an introduction to spatial data analysis. *Geographical Analysis* 38.

S. Rey and L. Anselin (2006) Recent advances in software for spatial analysis in the social sciences. *Geographical Analysis* 38.

L. Anselin, S. Sridharan, and S. Gholston (2006) Using exploratory spatial data analysis to leverage social indicator databases: the discovery of interesting patterns. *Social Indicators Research*.

S. Messner, G. Deane, L. Anselin, and B. Pearson-Nelson (2006) Locating the vanguard in rising and falling homicide rates among U.S. cities. *Criminology*.

O. Smirnov (2006) Computation of the information matrix for models with spatial interaction on a lattice. *Journal of Computational and Graphical Statistics*.

Book chapters

L. Anselin (2003) Spatial regression. In M. Lewis-Beck, A. Bryman, and T.F. Liao, editors, *The Sage Encyclopedia of Social Science Research Methods*. Thousand Oaks, CA: Sage Publications, pp. 1050–1051.

S. Messner and L. Anselin (2004) Spatial analyses of homicide with areal data. In M. Goodchild and D. Janelle, editors, *Spatially Integrated Social Science*. New York: Oxford University Press, pp. 127–144.

L. Anselin, R.J.G.M. Florax, and S. Rey (2004) Econometrics for spatial models, recent advances. In L. Anselin, R. Florax, and S. Rey, editors, *Advances in Spatial Econometrics: Methodology, Tools and Applications*. Berlin: Springer-Verlag, pp. 1–25.

L. Anselin (2005) Spatial statistical modeling in a GIS environment. In D. Maguire, M. Goodchild, and M. Batty, editors, *GIS, Spatial Analysis and Modeling*. Redlands, CA: ESRI Press, pp. 93–111.

L. Anselin (2006) Spatial econometrics. In T.C. Mills and K. Patterson, editors, *Palgrave Handbook of Econometrics: Volume 1, Econometric Theory*. Basingstoke: Palgrave Macmillan.

L. Anselin, J. Le Gallo, and H. Jayet (2006) Spatial panel econometrics. In L. Matyas and P. Sevestre, editors, *The Econometrics of Panel Data, Fundamentals and Recent Developments in Theory and Practice*. 3rd Edition. Dordrecht: Kluwer.

Conference proceedings

L. Anselin, I. Syabri, O. Smirnov, and Y. Ren (2001) Visualizing spatial autocorrelation with dynamically linked windows. In *Computing Science and Statistics 33. Proceedings of Interface 01, Orange County, CA, June 13–16, 2001* (CD-ROM).

L. Anselin, I. Syabri, and O. Smirnov (2002) Visualizing multivariate spatial correlation with dynamically linked windows. In L. Anselin and S. Rey, editors, *New Tools for Spatial Data Analysis: Proceedings of a Workshop*. Center for Spatially Integrated Social Science, University of California, Santa Barbara (CD-ROM).

L. Anselin, Y-W Kim, and I. Syabri (2002) Web-based spatial analysis tools for the exploration of spatial outliers. In *GIScience 2002, The Second International Conference on Geographic Information Science, Boulder, CO, Sept. 25–28*, pp. 12–15.

Presentations

GeoDa-related workshops, presentations, and training sessions (other than CSISS Specialist Meetings)

L. Anselin, I. Syabri, O. Smirnov, and Y. Ren, "Visualizing Spatial Autocorrelation with Dynamically Linked Windows", 33rd Symposium on the Interface of Computing Science and Statistics (Interface 01), Orange County, CA, June 13–16, 2001.

L. Anselin, "DynESDA and Exploratory Space-Time Analysis," Space-Time Information Systems Conference, BioMedware, Ann Arbor, MI, Jan. 11–12, 2002.

L. Anselin, "Introduction to Dynamic Exploratory Spatial Data Analysis using DynESDA", Seminar on Spatial and Temporal Data Analysis, TerraSeer Inc, Ann Arbor, MI, Sept. 12–13, 2002.

L. Anselin and I. Syabri, "Exploring Spatial Data with GeoDa", 49th Annual North American Meetings of the Regional Science Association International, San Juan, Puerto Rico, Nov. 10–13, 2002.

L. Anselin, Short Course on "Spatial Data Analysis", The University at Albany, SUNY, Albany, NY, May 19–21, 2003.

L. Anselin, "Current Developments in Spatial Statistics Software", Environmental Systems Research Institute (ESRI), Redlands, CA, May 28, 2003.

L. Anselin, "Exploratory Spatial Data Analysis and GeoDa" (short course), START Advanced Institute on Urbanization, Emissions and the Global Carbon Cycle, National Center for Atmospheric Research (NCAR), Boulder, CO, August 7, 2003.

L. Anselin, "Exploratory Spatial Data Analysis and GeoDa", American Sociological Association 2003 Annual Meeting, Atlanta, GA August 17–20, 2003.

L. Anselin, "New Software Tools for Spatial Econometric Analysis", International Conference on Health Policy Research, American Statistical Association, Chicago, IL, Oct. 17–19, 2003.

L. Anselin, "GeoDa, An Introduction to Spatial Data Analysis", 50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003.

L. Anselin and J. Koschinsky, "Exploring Spatial Data with GeoDa" (workshop), 100th Annual Meeting of the Association of American Geographers, Philadelphia, PA, March 14–18, 2004.

L. Anselin and I. Syabri, "GeoDa and Beyond: ESDA and Flow Data", 51st Annual North American Meetings of the Regional Science Association International, Seattle, WA, Nov. 10–13, 2004.

J. Koschinsky, "Exploring Spatial Public Health Data with GeoDa" (workshop), GeoHealth 2004, Wellington, NZ, Nov. 22–25, 2004.

L. Anselin, "GeoDa: Why, How and What is Next", Colloquium, Department of Geography, The Ohio State University, Columbus, OH, Jan. 6, 2005.

L. Anselin, "GeoDa, an Introduction to Spatial Data Analysis", Colloquium, Department

of Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, MA, Feb. 4, 2005.

L. Anselin and J. Koschinsky, "Exploring Spatial Data with GeoDa" (short course), University of Illinois, Urbana-Champaign, Urbana, IL, July 25–27, 2005.

L. Anselin and J. Koschinsky, "Exploring Spatial Data with GeoDa" (workshop), GeoComputation 2005, Eighth International Conference on GeoComputation, Ann Arbor, MI: July 31–Aug 3, 2005.

J. Koschinsky, "GeoDa: An Introduction to Spatial Data Analysis" (workshop), Eighth Annual International Crime Mapping Research Conference, Savannah, GA, Sept. 8, 2005.

J. Koschinsky, "Exploring Spatial Data with GeoDa" (short course), Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Bejing, China, Nov. 18–20, 2005.

Tools-related presentations

L. Anselin, "Spatial Effects in Econometric Practice in Environmental and Resource Economics", 2001 Annual Convention of the Allied Social Science Associations, New Orleans, LA, Jan 5–7, 2001.

L. Anselin and R. Moreno, "Properties of Tests for Spatial Error Components", 40th Annual Meeting of the Western Regional Science Association and Meeting of the Applied Econometrics Association, Palm Springs, CA, Feb. 25–28, 2001.

S. Rey and L. Anselin, "Open Source Software Tools for ESDA", 97th Annual Meeting of the Association of American Geographers, New York, NY, March 1–3, 2001.

L. Anselin and R. Moreno, "Properties of Tests for Spatial Error Components", Econometrics Workshop, Department of Economics, Texas A&M University, College Station, TX, April 26, 2001.

L. Anselin, "Introduction to Spatial Econometrics" (Pre-Conference Workshop on Spatial Analysis), Annual Meeting of the American Agricultural Economics Association, Chicago, IL, Aug 4, 2001.

L. Anselin, "Spatial Analysis, Approaches and Considerations." USDA ERS Panel on Food Stamp Fraud, Washington, DC, Feb. 6, 2002.

L. Anselin, "New Tools for Spatial Analysis in Social Science", 98th Annual Meeting of the Association of American Geographers, Los Angeles, CA, March 19–23, 2002.

L. Anselin, "Spatial Externalities, Spatial Multipliers and Spatial Econometrics", 2002 Joe Havlicek Jr. Memorial Lecture in Applied Econometrics, Dept. of Agricultural, Environmental and Development Economics, The Ohio State University, Columbus, OH, April 25, 2002.

L. Anselin, "Beyond Crime Mapping, Spatial Analytical Approaches", Workshop on GIS Research and Applications at the Department of Housing and Urban Development (HUD), National Research Council, Washington, DC, April 27, 2002.

L. Anselin, Y-W Kim, and I. Syabri, "Web-Based Spatial Analysis Tools for the Exploration of Spatial Outliers", GIScience 2002, Boulder, CO, Sept. 25–28, 2002.

L. Anselin and S. Sridharan, "Exploring Spatial and Temporal Patterns in Juvenile Violent Crime", 54th Annual Meeting of the The American Society of Criminology, Chicago, IL, Nov. 12–16, 2002.

L. Anselin, "Mapping and Analysis for Spatial Social Science", 101st Annual Meeting of the American Anthropological Association, New Orleans, LA, Nov. 20–24, 2002.

L. Anselin, "Tools for the Exploration of Space-Time Patterns in Concentration-Response Models", 2003 Annual Convention of the Allied Social Science Associations, Washington, DC, Jan 3–5, 2003.

L. Anselin, "Tools for the Exploration of Space-Time Patterns: Applications to Concentration-Response Models", Colloquium Series, School of Social Sciences, University of Texas at Dallas, Richardson, TX, Feb. 27, 2003.

L. Anselin, "Integrating Social Network and Spatial Analysis", Social Network and Spatial Analysis Workshop, National Consortium on Violence ReSarasota, FL, March 6, 2003.

L. Anselin, "Tools for the Exploration of Space-Time Patterns", DEMSEM Colloquium, University of Wisconsin, Madison, WI, April 22, 2003.

O. Smirnov, "Computation of the Information Matrix for Models of Spatial Interactions", Society of Computational Economics 9th Annual Conference on Computing in Economics and Finance, University of Washington, Seattle, WA, 11–12 July 2003.

L. Anselin, "Spatial Statistical Modeling", Modeling and GIS Workshop, Environmental Systems Research Institute, Redlands, CA, Sept. 25–26, 2003.

O. Smirnov and L. Anselin, "A Parallel Method for Maximum Likelihood Estimation of Models with Spatial Dependence", 50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003.

L. Anselin, "Spatial Analytical Approaches to Concentration-Response Modeling, Methods and Tools", Symposium on Spatial Information Science for Human and Social Science, University of Tokyo, Tokyo, Japan Jan 29–30, 2004.

L. Anselin and J. LeGallo, "Panel Data Spatial Econometrics with PySpace", 100th Annual Meeting of the Association of American Geographers, Philadelphia, PA, March 14–18, 2004.

L. Anselin and S. Rey, "PySAL, a Python Library for Spatial Analytical Functions", Annual Meeting of the Association of American Geographers, Denver, CO, April 5–9, 2005.

L. Anselin, "Under the Hood: Issues in the Specification, Estimation and Implementation of Spatial Regression Models." Seminar, Development Economics Research Group, The World Bank, Washington, DC: May 18, 2005.

L. Anselin and S. Rey, "PySAL, a Python Library for Spatial Analytical Functions" GeoComputation 2005, Eighth International Conference on GeoComputation, Ann Arbor, MI: July 31–Aug 3, 2005.

L. Anselin, "A Look at 25+ Years of Spatial Econometrics: Past, Present and Future." Inaugural Arthur Getis Lecture in Spatial Analysis, San Diego State University, San

Diego, CA: October 7, 2005.

S. Rey, J. Duque, and L. Anselin, "Clustering Components in the Python Spatial Analysis Library (PySAL)", 52nd Annual North American Meetings of the Regional Science Association International, Las Vegas, NV, Nov. 10–12, 2005.

Training

Anselin continues to involve graduate students in the development and application of the software tools. *GeoDa* is a central component of his graduate course in Spatial Analysis and has also been adopted in lower-level courses on methods in the Geography Department at UIUC. The R code for spatial regression as well as the code in PySpace is used heavily in Anselin's graduate Spatial Econometrics course. Feedback from this experimental use was instrumental in improving the user interface and inspiring current and future functionality.

In addition, training was provided through various workshops and short courses (see Presentations above), as well as in a special three-day Short Course on Exploring Spatial Data with GeoDa, held at UIUC in July 2005. Also, a presentation on GeoDa is part of the Progress in GIScience eSeminar Series organized by the World University Network consortium of universities in 2005–06.

Both Syabri (Geography) and Kho (Computer Science) are making their work in the Tools project part of their own research agenda and dissertation. Syabri completed a dissertation specifically dealing with flow data in December 2005 [Syabri, I. (2005) *Exploratory Spatial Data Analysis for Flow Data*. Department of Geography, University of Illinois, Urbana-Champaign].

Future Plans

All current supporting materials available on the SAL and GeoDa websites will be maintained and updated in the future. The sites themselves are being converted to state-of-the-art content-management servers to allow more intensive interaction with the user community (through wiki, podcasts, etc.).

A software-development cycle has been instituted jointly by Anselin's team at UIUC and Rey's team at SDSU (funded by an NSF HSD Exploratory Grant) that consists of prototyping code in Python for inclusion in the PySAL library and testing, after which the code is optimized in C++ for inclusion in OpenGeoDa. Several custom frontends are being developed for PySAL, to address specific communities (e.g., geared to rate smoothing for epidemiologists, space–time convergence analysis for regional scientistis, etc.). Both OpenGeoDa and PySAL will be open-source projects maintained on sourceforge.net. Behind them stands a small group of core developers, drawn from Anselin's and Rey's current and former graduate students. Current efforts are underway to obtain further funding to support these efforts.

Other related efforts are the extension of OpenGeoDa to deal with very large data sets, in cooperation with staff from the National Center for Supercomputing Applications (NCSA) at UIUC and supported by a Faculty Fellow grant to Anselin. This effort is also supported in part by the NSF-funded Mid-America Earthquake center at UIUC, which is considering the integration of some of OpenGeoDa's functionality into their MAEVIZ visualization and decision-support tool (developed by NCSA staff). It is anticipated that these two activities will lead to longer-term funding to support continued development of the software tools.

As part of a separate project funded by the NSF HSD competition ("Hedonic Models of Location Decisions with Applications to Geospatial Micro-Data", Matzkin, Heckman, Anselin, Boyd) the implementation of OpenGeoDa is being explored as a spatial analytical engine on the Census Data Cluster computer serving the Census Research Data Centers. In addition, functionality is developed in PySAL to handle the analysis of spatial micro data.

Finally, plans are underway to develop an e-Learning series of courses related to *GeoDa* and spatial-data analysis, in cooperation with the UIUC Office of Continuing Education. These e-Learning courses would become part of a planned graduate GIScience curriculum under consideration by the World University Network.

V. Learning Resources

CSISS aims to develop learning resources covering core spatial concepts and exemplary research approaches. These include lecture outlines, exercises, interactive learning modules, and demonstrations, all made available through the CSISS Learning Resources Portal at http://www.csiss.org/learning_resources. In 2002, an effort was initiated to flag resources for specific social science disciplines, implemented through linkage to outstanding examples of syllabi on spatial analytic courses (http://www.csiss.org/learning_resources/content/syllabi/). This is seen as a first step to establishing a strong identity for the resource in the user community and as an aid to scholars wishing to incorporate spatial perspectives that are relevant to their disciplines.

The CSISS Learning Resources are comprised primarily of html-based resources, searchable via two principal tools: 1) a Web browser, and 2) a PHP/MySQL-based search form that queries a local database of CSISS Learning Resource metadata.

GIS Cookbook

The CSISS Cookbook was devised as a means of providing simple tutorials on basic GIS operations. It is aimed at social-science researchers with minimum knowledge of GIS and its underlying principles, and minimal knowledge of geography. Such people frequently report a need for basic help in standard GIS operations of relevance to social science. For example, a social scientist may have considerable difficulty making a choice between available map projections, or in understanding how to go about the task of geocoding. A textbook or course would provide far too much information in such cases; rather, it seems that something more akin to a cookbook would be appropriate, providing a short tutorial, examples, guidance in overcoming common mistakes, and references to additional information.

In the summer of 2002 NSF provided supplementary funding to CSISS under its Research Experiences for Undergraduates (REU) program, sufficient to fund three UCSB undergraduates for three months each. These students had all taken a full undergraduate sequence of courses in GIS. Supervision and guidance were provided by a graduate student and by CSISS faculty. An overall design for the cookbook was developed, with the intention of continuing to populate the book in the coming years. Tools were developed by the CSISS Webmaster to support the input of material into a series of standard cookbook templates.

By the end of the summer the REU students had completed the nucleus of a superlative series of documents. Geocoding was given some prominence, on the grounds that it is frequently used by social scientists to provide geographic references for survey records, can be technically difficult, and is subject to numerous misapprehensions. The finished documents were mounted on the CSISS website, and have been well received by the user community. The REU students were integrated into the broader REU-supported summer internship program at UCSB, where they had the opportunity to mix with students in other disciplines, and to experience something of the nature of multidisciplinary research,

as well as presenting their own work. The project was presented to the CSISS Advisory Board in October 2002, and very well received.

Video Resources

Two workshops held in the summer of 2002 were video taped for inclusion on the CSISS website on the learning resources page. Videos of the workshops were edited and prepared by Gamaiel Zavala (CSISS webmaster). The videos can be found at http://www.csiss.org/streaming_video/. They include the workshops "Map Making and Visualization of Spatial Data in the Social Sciences" and "Spatial Pattern Analysis in a GIS Environment. In the summer of 2003 the workshop "Geographically Weighted Regression and Associated Statistics" was also videotaped, edited, and added to the online collection.

VI. Place-Based Search

CSISS is interested in facilitating spatial social science. Many users of geographic information systems and other tools for spatial analysis report that the majority of their time is spent in searching for suitable data, and bringing data into compatibility, before analysis can begin. Any techniques that can be used to reduce the complexity of this stage, the time taken to complete it, and the knowledge needed to complete it successfully would clearly be welcome in the social science research community. One of the seven CSISS programs is directed specifically at this problem, under the title of Place-Based Search.

Place-based search is defined as the process of searching for data and information related to a place, defined by a suitable means such as a placename, or a set of coordinates. It is a central process of a geolibrary, defined as a digital library whose primary search mechanism is based on geographic location. Geolibraries can store and retrieve any information related to a place, including maps and images but also reports, photographs, studies, papers, and even pieces of music. In recent years substantial investments have been made in building geolibraries, led in part by UCSB's Alexandria Digital Library, an effort funded by NSF since 1994. The place-based search initiative of CSISS seeks to leverage this investment for the specific needs of social science researchers.

CSISS has described the objectives of place-based search, and has provided links to Alexandria and to other geolibraries. We developed a prototype place-based search engine based on ESRI's ArcIMS and made it accessible through the CSISS website. The engine allows a researcher to define a need, by specifying a geographic area of interest and other attributes of the needed data, and then automatically searches against four of the world's most prominent archives of social-science data. It uses the DDI (Data Documentation Initiative) metadata standard developed by an international consortium of social scientists.

Subsequent efforts focused on the next logical step in this process, the refinement of DDI as a tool for describing the spatial aspects of data. The standard metadata tool for geographic data is the Federal Geographic Data Committee's Content Standard for Geospatial Metadata (www.fgdc.gov), which includes elaborate facilities for describing the geographic aspects, but pays too little attention to attributes to satisfy the needs of social scientists. On the other hand DDI pays too little attention to locations to satisfy the needs of geolibraries and our search engine. In August 2002 we convened a joint meeting of the DDI geography working group and CSISS, in Santa Barbara, in order to explore ways in which the two standards could be made to work together. The DDI working group has subsequently reported back to the DDI consortium.

VII. Virtual Community ([www.csiss.org]())

CSISS is developing an open, virtual community to share spatial analytic software, foster discussion about spatial approaches in the social sciences, provide learning resources, and highlight information on workshops, conferences, and the latest innovations and applications of spatial analysis. The vehicle for these community-building and outreach efforts is [http://www.csiss.org/](). CSISS aims to position this website as the primary port-of-call for researchers and students of spatial analysis in the social sciences. To this end, it has developed a specialized Internet search engine to identify relevant resources on the Web and provides consolidated bibliographical resources derived from a broad range of on-line sources.

CSISS Website

The CSISS website, [http://www.csiss.org/](), is a central component of CSISS programs. The objective of [CSISS.org]() is to provide resources, tools, and methods to integrate spatial concepts into the theories and practices of social science. The website is intended to encourage and facilitate: (a) the increased awareness of existing spatial knowledge, making it more accessible, and (b) the generation and dispersal of new spatial knowledge and resources. All of the core programs are delivered or assisted through the website. Website content has grown to well over 600 static and dynamic pages, reflecting the growing infrastructure and content related to the core programs of CSISS. The website role for each of the core programs is described below:

National Workshops
The website serves as the central hub for the summer CSISS workshops. The entire process from advertisement to participant application and all the way through the selection and review process takes place on the website. Workshop materials, such as agendas, papers, participant lists, and travel and accommodations information, are housed onsite. Information on past workshops, including selected video clips, is also available.

Specialist Meetings
The website also serves as a central point of access for CSISS specialist meetings by providing details on the meeting's agenda, description, venue, and participant list. It also hosts pre-meeting position statements and final reports. Online access to these resources greatly simplifies the organization and distribution process for these meetings.

Learning Resources
One of the primary objectives of the CSISS website is to deliver learning resources in spatial social science. Learning Resources include course syllabi, lecture outlines, presentations, learning modules, exercises, and demonstrations that convey spatial thinking and analysis.

Along with an expanded collection of syllabi is the addition of an experimental method of cross-referencing resources. A collapsible "related info" box is accessible under each

discipline on the syllabi page; the box contains categorized links to other resources on the site that are directly related to the given discipline.

Best Practices and *CSISS Classics*
An online preview and supplement for the CSISS Best Practice publication *Spatially Integrated Social Science* has been made available on the CSISS site. This resource provides the full table of contents with links to pages for each chapter. The publication background, objectives, and contributor biographies are also provided. Each chapter page contains the abstract, tables, and color illustrations for the chapter. Authors have also provided further supplementary materials where available.

Almost 50 examples of best practice in spatial analytic social science have been made available in the *CSISS Classics* collection. An interface has been implemented to allow the user to organize the Classics by year, discipline, and spatial principle, in addition to the native ordering by name of the innovator.

Spatial Tools
The Spatial Tools section of the website has grown to include select tools, portal links, a search engine, and an offsite link to the tools project headed by Luc Anselin at the University of Illinois, Urbana-Champaign. Remote database access has been provided for Luc to manage and update the portal links and select tools pages. A page has also been set up on the site to showcase the popular GeoDa software.

CSISS Search Engines and Place-Based Search
Search is the most common activity preformed on the Web. CSISS has employed five search tools to facilitate the introduction of spatially integrated techniques to students and researchers visiting the site on the Web. The search tools use Texis, a commercial product produced by Texis. This product is an industrial-strength search and retrieval database program similar to those used by Google.com, Altavista.com, and others.

The search tools support a significant fraction of the traffic and public outreach provided by CSISS on the Web. In terms of entry points, (i.e., how users find the site) the search tools provide between 10 to 20 percent of the total traffic on the site.

There are six search tools currently available on the site: Literature Search, Social Science Data Archive Search, Spatial Tools Search, Site Search, Internal Site Search, and finally Spatial Resources on the Web.

The Literature Search tool is a compilation of hand-selected articles and books on the whole of spatially integrated social science. While the literature collection is hand selected, the search software provides users with natural language and Boolean queries, as well as with the ability find similar and related documents. The Literature Search tool currently accounts for between one and two percent of the total visitors or traffic on the site.

The Social Science Data Archive Search tool uses the ArcIMS architecture to allow users to select a geographic region and topic and return a series of results from the Australia,

UK, Swedish, and ICPSR Data Archives. The goal of the project is to provide users with a spatial interface to these archives, all of which support the DDI (Data Document Initiative) metadata architecture.

The Spatial Tools Search Engine provides users with access to a database of hundreds of software products and reviews appropriate for facilitating spatially integrated research in the social sciences. Luc Anselin originally compiled this index of URLs and software archives. Currently, the Spatial Tools Clearinghouse references over 700 individual software titles.

The Site Search allows users to explore and navigate CSISS.org directly, as opposed to using textual links or menu bars. The goal of this feature is to improve internal visibility and to make resources readily available to our site's visitors. This resource is regularly one of the top 30 resources visited on the site.

By far the most popular resource of value to our users is the Spatial Resources on the Web feature. This resource is comprised of a compilation of links related to spatially integrated resources available on the Internet. The list was originally comprised of external links from CSISS and the NCGIA and has been augmented by search queries generated by our visitors. The theory is that if a user is interested in a subject related to the field that is not in our database, then we find that resource and add it to the searchable index. Links that are regularly of use to our users (as measured by outgoing traffic) are maintained; those that are not eventually fade from our index.

Currently, the top search queries to this database are as follows:
- GIS (or Map Making)
- Spatial Econometrics (or Spatial Economics)
- Spatial Interaction Modeling (or Modeling, Model, etc)
- Spatial Decision Support Systems (or SDSS)
- Spatial Statistics (or Quantitative Techniques)
- Spatial Theory (or Geographic Theory)
- Segregation (or Discrimination)
- Crime Map (or Crime Mapping)
- Spatial Autocorrelation

Website Look and Feel
Site templates incorporate a clean, professional visual quality and optimized code to allow for quicker downloads. Drop-down menus have been implemented to provide single click access to key areas of the site. A collapsible site map provides a complete site overview on a single page.

Evaluation
Feedback forms are available throughout the site to enable users to comment on the various resources. The *CSISS Classics* get a lot of constructive feedback from users who choose to share their thoughts.

Highly detailed traffic logs of the CSISS website have been kept and analyzed by *WebTrends Log Analyzer*. From 16 November 2003 to 20 August 2004, a 9-month period near to the end of the original NSF award, there were 239,303 visitor sessions on the site, for an average of 857 per day. Each visitor viewed an average of 2.6 pages, and remained at the site for an average of 18 minutes. 104,438 unique visitors were logged, and of these 17,748 visited more than once.

Some of the growth in usage over the past few years can be attributed to improvements made by CSISS staff in page metadata and correctly formed URLs, both of which contribute to the successful spidering of dynamic content. This is reflected in the high search engine visibility of the *CSISS Classics*, which themselves bring a large amount of traffic to the site. Of the most popular search engines, Google has sent by far the most users to the site, referring over 35,000 in this 9-month reporting period. Other sites delivering significant traffic to the CSSIS site are anthro.net with over 12,000 and Yahoo with close to 7,500.

The most requested areas of the site during this period included *CSISS Classics* (270,046 visits), Events (132,337), Learning Resources (65,333), About Us (107,517), Tools Clearinghouse (34,124), Spatial Resources (21,679), *GIS Cookbook* (82,064) and Best Practices (31,425).

The following table summarizes data for this 9-month period:

Statistics - Report Range: 11/16/2003 00:00:00 - 08/20/2004 23:59:59		
Hits	Entire Site (Successful)	1,868,244
	Average Per Day	6,696
	Home Page	25,165
Page Views	Page Views (Impressions)	618,759
	Average Per Day	2,217
	Document Views	419,046
Visitor Sessions	Visitor Sessions	239,303
	Average Per Day	857
	Average Visitor Session Length	00:18:06
	International Visitor Sessions	0%
	Visitor Sessions of Unknown Origin	100%
	Visitor Sessions from United States	0%
Visitors	Unique Visitors	104,438
	Visitors Who Visited Once	86,690
	Visitors Who Visited More Than Once	17,748

These data were generated by *WebTrends*, a registered trademark of WebTrends Corporation.

RESEARCH-RELATED ACTIVITIES
CSISS EXECUTIVE COMMITTEE

Members of the CSISS Executive Committee have prepared narrative statements and listings of publications and presentations covering their scholarly activities over the period 1 May 2003–30 November 2005, since the most recent annual report. In many cases these reflect activities outside the direct context of CSISS. However, given the important role of outreach to the fulfillment of CSISS infrastructure objectives, these activities are useful indicators of CSISS contact with the various research communities within the social sciences.

Michael F. Goodchild, Principal Investigator

As before, my efforts during this period have been directed at organizing CSISS programs, overseeing the organization, managing our relationships with the Advisory Board, and promoting CSISS among new audiences. I have also directed the financial and substantive reporting activities related to the no-cost extension and final closure of the NSF core funding. In the area of *national workshops*, I participated as an instructor in our workshop on spatial analysis using GIS in 2003, 2004, and 2005, and also participated as an instructor in workshops organized under the SPACE and GIS Population Science programs.

I made many presentations on the work of CSISS in various contexts. In November 2004 I attended the launch of the National Center for Geocomputation at the National University of Ireland, Maynooth, and gave a keynote presentation. In December 2004 I participated similarly in the opening conference of the Australian Research Council's Research Network on Spatially Integrated Social Science in Brisbane. The core concepts of CSISS were the basis for a Jacob Marschak Interdisciplinarly Colloquium on Mathematics in the Behavioral Sciences at the University of California, Los Angeles in November 2004. Other presentations and activities are detailed below.

Conference and other presentations

"What Does Google Earth Mean for the Spatial Sciences?" Plenary Address, Spatial Sciences Conference, Melbourne, Australia, September 2005.

"The Transition of GIS from Academic Research Novelty to Billion-Dollar Industry". Annual Conference, CRC-SI, University of Melbourne, September 2005.

"Towards a General Theory of Geographic Representation in GIS". International Symposium on Spatio-Temporal Modeling, Spatial Reasoning, Spatial Analysis, Data Mining and Data Fusion (STM 05), Beijing, August 2005.

"Uncertainty and Interoperability: The Areal Interpolation Problem". International Symposium on Spatial Data Quality (ISSDQ 05), Beijing, August 2005.

"GIScience and Interoperability". Joint Research Centre of the European Commission, Ispra, Italy, July 2005.

"Enabling Spatial Analysis: The Center for Spatially Integrated Social Science". Research Society on Alcoholism, Santa Barbara, June 2005.

"Globalizing GIS". Opening Keynote, GISPlanet 2005, Estoril, Portugal, May.

"Future Directions for Geolibraries". Cartography Users Advisory Committee, Library of Congress, May 2005.

"What Do GIS Professionals Need to Know?" GeoSpatial World 2005, San Francisco, April.

"The Fundamental Laws of GIScience". University of Texas, Austin, April 2005.

"Geo-Information for Disaster Management". Keynote, First International Conference on Geo-Information for Disaster Management, Delft, the Netherlands, March 2005.

"Geographic Information Systems and Science: Enabling a Location-Based Technology". Hong Kong Polytechnic University, March 2005.

"Directions in GIS". Keynote, Coastal Geotools 05, Myrtle Beach, SC, March.

"Best Practices for Visualizing Uncertain Information in Geography". National Research Council Workshop, "Toward Improved Visualization for Uncertain Information", Washington DC, March 2005.

"Exploiting Spatial Technologies in Health Research". Charles Drew University, February 2005, and the University of Southern California, January 2005.

"Spatially Integrated Social Science". Inaugural Conference, Australian Research Council Research Network in Spatially Integrated Social Science, Brisbane, December 2004.

"Bits of Geography: Maps and Mapping in the Digital Age". Haynes Lecture, Texas A&M University, November 2004.

"The Case for Space". Jacob Marschak Interdisciplinary Colloquium on Mathematics in the Behavioral Sciences, UCLA, November 2004.

"From Vespucci to GIS". International Conference "Vespucci e la Modernita", Florence, Italy, October 2004.

"Geographic Information Systems and Science: Enabling a Location-Based Technology". National Centre for Geocomputation, National University of Ireland Maynooth, October 2004.

"Cutting Edge Spatial Solutions in the Globalized World". International Symposium and Exhibition on Geoinformation 2004, Kuala Lumpur, September

"GIS: Time, for a Change", ESIG 2004, Lisbon, June.

"Educating the Next Generation of Geospatial Professionals", Intergraph Geospatial World conference, Miami, May 2004

"Thinking Spatially in the Social Sciences", Stanford University, May 2004

"The Fundamental Laws of GIScience", ESRI and University of Redlands, April, 2004

"Acknowledging and Representing Uncertainty", Conference on History and Geography: Assessing the Role of Geographical Information in Historical Scholarship, Newberry Library, Chicago, March 2004.

"Bits of Geography", Hunter College, CUNY, March 2004.

"GIScience, Geography, Form, and Process", Presidential Plenary, Centennial Meeting of the Association of American Geographers, Philadelphia, March 2004.

"Spatial Perspectives for the Globe", Keynote Address, Specialist Meeting on Globalization in the World System: Mapping Change over Time", University of California, Riverside, February 2004.

"Models for Uncertainty in Area-Class Maps", Fifth Australasian Postgraduate Workshop on GIS, Social and Environmental Modelling, Kioloa, New South Wales, February 2004.

"The Fundamental Laws of GIScience", Seoul National University, November 2003.

"Spatially Enabled E-Government", Keynote Address, 8th International Seminar on GIS, Seoul, November 2003.

"Digital Earth: Recent Technical Progress", Keynote Address, First Taipei International Conference on Digital Earth, November 2003.

"Bits of Geography", Hooker Distinguished Lecture, McMaster University, October 2003.

"Augmenting Geographic Reality", McMaster University School of Geography and Geology, October 2003.

"Bits of Geography", Chancellor's Distinguished Lecture, Louisiana State University, October 2003.

"Recent Advances in GIScience", National Center for Atmospheric Research, Boulder, Colorado, September 2003

"GIS and Modeling", Environmental Systems Research Institute, September 2003.

"The Fundamental Laws of GIScience", Environmental Systems Research Institute, September 2003.

"The GIScience Research Agenda: Inventory and Prospect", Royal Geographical Society/Institute of British Geographers Annual Conference, September 2003.

"The Fundamental Laws of GIScience", Department of Geography, University of Cambridge, September 2003.

"Spatial Data Infrastructure and Science", Guest Lecture, Vespucci Summer Institute, Florence, August 2003.

"The Spatial Web", Guest Lecture, Vespucci Summer Institute, Florence, August 2003.

"The Fundamental Laws of GIScience", Keynote, Annual Assembly, University Consortium for Geographic Information Science, Monterey, CA, June 2003

"Finding the Mainstream", Keynote, ScanGIS 2003, Helsinki, June.

Publications

Articles in refereed journals

C.J. Legleiter and M.F. Goodchild (2005) Alternative representations of in-stream habitat: classification using remote sensing, hydrologic modeling, and fuzzy logic. *International Journal of Geographical Information Science* 19(1): 29–50.

M.F. Goodchild (2004) GIScience: geography, form, and process. *Annals of the Association of American Geographers* 94(4): 709–714.

M.F. Goodchild (2004) A general framework for error analysis in measurement-based GIS. *Journal of Geographical Systems* 6(4): 323–324.

Y. Leung, J.-H. Ma, and M.F. Goodchild (2004) A general framework for error analysis in measurement-based GIS Part 1: The basic measurement-error model and related concepts. *Journal of Geographical Systems* 6(4): 325–354.

Y. Leung, J.-H. Ma, and M.F. Goodchild (2004) A general framework for error analysis in measurement-based GIS Part 2: The algebra-based probability model for point-in-polygon analysis. *Journal of Geographical Systems* 6(4): 355–379.

Y. Leung, J.-H. Ma, and M.F. Goodchild (2004) A general framework for error analysis in measurement-based GIS Part 3: Error analysis in intersections and overlays. *Journal of Geographical Systems* 6(4): 381–402.

Y. Leung, J.-H. Ma, and M.F. Goodchild (2004) A general framework for error analysis in measurement-based GIS Part 4: Error analysis in length and area measurements. *Journal of Geographical Systems* 6(4): 403 –428.

M.F. Goodchild (2004) The Alexandria Digital Library: review, assessment, and prospects. *D-Lib Magazine* 10(5).

M.F. Goodchild (2004) The validity and usefulness of laws in geographic information science and geography. *Annals of the Association of American Geographers* 94(2) 300–303.

M.F. Goodchild (2003) Geographic information science and systems for environmental management. *Annual Reviews of Environment and Resources* 28: 493–519.

M.F. Goodchild and R.P. Haining (2004) GIS and spatial data analysis: converging perspectives. *Papers in Regional Science* 83: 363–385.

S.J. Crosier, M.F. Goodchild, L.L. Hill, and T.R. Smith (2003) Developing an infrastructure for sharing environmental models. *Environment and Planning B: Planning and Design* 30: 487–501.

D.Z. Sui and M.F. Goodchild (2003) A tetradic analysis of GIS and society using McLuhan's law of the media. *Canadian Geographer* 47(1): 5–17.

D.R. Montello, M.F. Goodchild, J. Gottsegen, and P. Fohl (2003) Where's downtown? Behavioral methods for determining referents of vague spatial queries. *Spatial Cognition and Computation* 3(2,3): 185–204.

M.-P. Kwan, D.G. Janelle, and M.F. Goodchild (2003) Accessibility in space and time: a theme in spatially integrated social science. *Journal of Geographical Systems* 5(1): 1–4.

M.F. Goodchild and J. Zhou (2003) Finding geographic information: collection-level metadata. *GeoInformatica* 7(2): 95–112.

Books

D.J. Maguire, M. Batty, and M.F. Goodchild, editors (2005) *GIS, Spatial Analysis, and Modeling*. Redlands, CA: ESRI Press.

P.A. Longley, M.F. Goodchild, D.J. Maguire, and D.W. Rhind (2005) *Geographic Information Systems and Science*. Second Edition. New York: Wiley.

M.F. Goodchild and D.G. Janelle, editors (2004) *Spatially Integrated Social Science*. New York: Oxford University Press.

Articles in books

M.F. Goodchild (2005) Preface. In A. Mitchell, *The ESRI Guide to GIS Analysis. Volume 2: Spatial Measurements and Statistics*. Redlands, CA: ESRI Press.

M.F. Goodchild, P.C. Kyriakidis, P. Schneider, and J. Sifuentes (2005) Uncertainty and interoperability: the areal interpolation problem. In L. Wu, W. Shi, Y. Fang, and Q. Tong, editors, *Proceedings of the Fourth International Symposium on Spatial Data Quality (ISSDQ 05), Beijing, August 25–26, 2005*.

M.F. Goodchild (2005) GIS and modeling overview. In D.J. Maguire, M. Batty, and M.F. Goodchild, editors, *GIS, Spatial Analysis, and Modeling*. Redlands, CA: ESRI Press, pp. 1–18.

M.F. Goodchild (2005) Geographic information systems. In *Encyclopedia of Social Measurement* 2: 107–113.

M.F. Goodchild (2004) Geographic information systems. In W.S. Bainbridge, editor, *Berkshire Encyclopedia of Human–Computer Interaction: When Science Fiction Becomes Science Fact*. Great Barrington, MA: Berkshire Publishing Group, pp. 281–288.

M.F. Goodchild, D.M. Johnston, D.J. Maguire, and V.T. Noronha (2004) Distributed and mobile computing. In R.B. McMaster and E.L. Usery, editors, *A Research Agenda for Geographic Information Science*. Boca Raton: CRC Press, pp. 257–286.

M.F. Goodchild (2004) Preface. In R.B. McMaster and E.L. Usery, editors, *A Research Agenda for Geographic Information Science*. Boca Raton: CRC Press.

M.F. Goodchild (2004) Foreword. In L. Anselin, R.J.G.M. Florax, and S.J. Rey, editors, *Advances in Spatial Econometrics: Methodology, Tools and Applications*. New York: Springer, pp. ix–x.

P.C. Kyriakidis, X. Liu, and M.F. Goodchild (2004) Geostatistical mapping of thematic classification uncertainty. In R.S. Lunetta and J.G. Lyon, editors, *Remote Sensing and GIS Accuracy Assessment*. Boca Raton: CRC Press, pp. 145–162. Also published in R.S. Lunetta and J.G. Lyon, editors, *Geospatial Data Accuracy*

Assessment. Report EPA/600/R-03/064. Washington, DC: Environmental Protection Agency, pp. 171–190.

M.F. Goodchild (2004) Desafios à matemática na geografia. In M.P.S. de Oliveira, editor, *Teias Matemáticas: Frentes na Ciência e na Sociedade*. Coimbra, Portugal: Imprensa da Universidade de Coimbra, pp. 121–140.

M.F. Goodchild and D.G. Janelle (2004) Thinking spatially in the social sciences. In M.F. Goodchild and D.G. Janelle, editors, *Spatially Integrated Social Science*. New York: Oxford University Press, pp. 3–22.

M.F. Goodchild (2004) Scales of cybergeography. In E. Sheppard and R.B. McMaster, editors, *Scale and Geographic Inquiry: Nature, Society, and Method*. Malden, MA: Blackwell, pp. 154–169.

Other publications

M.F. Goodchild (2004) What is education doing in the academy? Geo-spatial technologies in higher education. In J. Thurston, editor, *Yearly Focus 2004/2005: GIS, GPS and Mapping*. Emmelord, Netherlands: CMedia Productions.

M.F. Goodchild (2004) [Social sciences: interest in GIS grows](). *ArcNews* 26(1):1-4.

Donald G. Janelle, Program Director

As CSISS Program Director since January 2000, I have worked closely with Michael Goodchild to oversee the integration of CSISS programs toward the common goal of building social science infrastructure. This involved extensive outreach to the social and behavioral sciences to enhance the fundamental role that spatial perspectives play in achieving cross-disciplinary communication and improved spatially informed research. Since the last report to NSF, in May 2003, outreach activities have included the organization of conference workshops and sessions for a joint meeting of the American Agricultural Economics Association and the Rural Sociology Society in Montreal in July 2003 and for the American Sociological Association in Atlanta in August 2003. I made program-related presentations at these sessions in addition to other presentations at meetings of the Social Science History Association in Chicago in November 2004 and the Crime Mapping Conference in Savannah in September 2005.

One of my primary CSISS efforts has been to organize and coordinate the offering of summer week-long workshops; 36 workshops have taken place since the inception of the program, serving more than 380 researchers from several disciplines. Other CSISS activities included organizational work and Web-resource development in association with eight different CSISS-sponsored Specialist Meetings, the most recent being an October 2005 meeting co-sponsored with the U.S. Federal Highway Administration to explore GPS-gathered space-time activity data and time-geography modeling for applications in transportation demand modeling. In January 2004, Oxford University Press released the CSISS-organized book that I co-edited with Mike Goodchild). *Spatially Integrated Social Science* draws together original research chapters that demonstrate applications of spatial thinking in several social science disciplines.

Other principal duties involved supervising the CSISS research and development teams (graduate students and REU undergraduates) in the production and dissemination of resources for the CSISS website, working closely with the CSISS Webmaster to make resources easily accessible to site users. I also structured the agenda for annual meetings of the CSISS Scientific Advisory Board and for monthly meetings of the CSISS Executive Committee, both of which provided oversight on the program's activities for consistency with the CSISS Strategic Plan.

To help further the objectives of CSISS beyond the funding period that ended in September 2004, I have been involved in two recently funded programs. I am the PI on the NSF DUE 0231263 award for SPACE (Spatial Perspectives on Analysis for Curriculum Enhancement), which is focused on the national dissemination of spatial analysis in the curricula of the social sciences. This program began in October 2003 and runs through September 2006. The second program is funded through NICHD as a national training program in GIS and Population Science to advance spatial analytic skills for research among PhD candidates. The program PI is Stephen Matthews at Pennsylvania State University. UCSB is a partner in the project (Mike Goodchild and I are co-PIs from UCSB). The program offered 2-week-long workshops at PSU and UCSB in summer 2005 and will repeat this in summer 2006. The program also features a substantive initiative to develop Web-related resources.

Current research interests focus on space-time analyses of individual behavior, the time-geography of cities, the temporal-spatial ordering of social systems, and the role of space-adjusting technologies in structuring new patterns of social and economic organization. The interdisciplinary context of this work has provided a base for representing the interests of CSISS to a broad community of social and behavioral scientists. From January 2002 to January 2005, I served as North American Coordinator of the STELLA (Sustainable Transport in Europe and Links and Liaisons with America) focus group on 'ICT, Innovation and the Transport System'. In this capacity, I worked with my European counterpart (Dr. Andrew Gillespie) to organize three meetings of the research network -- the first in January 2002 at NSF in Arlington attracted more than 50 transportation researchers from the social sciences. The other meetings took place in Newcastle UK in May 2003 and in Budapest in April 2004. Other STELLA conference and workshop activities that I took part in occurred in Amsterdam, Brussels, Bologna, Montreal, Santa Barbara, Athens, Fairfax, and Washington.

In March 2004, I completed a five-year appointment as co-chair of the Centennial Planning Committee for the Association of American Geographers. One of the outcomes of this effort was a co-edited commemorative volume of contemporary research in geography, *WorldMinds*, sponsored by the AAG and published by Kluwer Academic in early 2004.

Presentations

"Policy issues on Transportation, Information, and Communication Technologies" (with Andrew Gillespie), STELLA Transatlantic Thematic Network Policy Issues Forum, Brussels Belgium, 19 June 2003.

"Comments on the Role of Space-time Activity Data for Sustainable Transportation", Mo.Ve International Forum on Sustainable Mobility in European Metropolitan Areas, Verona, Italy, 23-24 October 2003.

"Issues in Space–Time Accessibility", CSISS Workshop on Accessibility in Space and Time, The Ohio State University, Columbus, Ohio, 8 July 2003.

"CSISS Resources for Research and Teaching", Rural Sociological Society, American Agricultural Economics Association, Montreal, Quebec, 26 July 2003.

"CSISS Resources for Research and Teaching", American Sociological Association, Atlanta, Georgia, 17 August 2003.

"Synthesis on ICT and Transportation Research" (with A Gillespie), STELLA Transatlantic Thematic Network Focus Group Workshop on ICT, Innovation and the Transport System, Budapest, Hungary, 23 April 2004.

"Synthesis Notes on ICT, Innovation, and the Transport System" (with A Gillespie), STELLA Topical Users Meeting, Bologna, Italy, 8-9 October 2004.

"Time and the City: Synoptic Analysis of Space-time Activity Systems", Mo.Ve International Forum on Sustainable Mobility in European Metropolitan Areas, Venice, Italy, 21-22 October 2004.

"Time Geography and the Behavioral Ecology of Cities", Association of American Geographers, Denver, Colorado, 5-9 April 2005.

"Introduction to CSISS" (presented at CSISS workshops in 2003 (Ohio State University, UC Santa Barbara) and in 2004 (UC Santa Barbara).

"Introduction to SPACE" (presented at SPACE workshops in 2004 (Ohio State University, UC Santa Barbara, San Diego State University) and 2005 (Ohio State University, UC Santa Barbara, and San Francisco State University)

"Introduction to the NICHD GIS Population Science Program" (presented at GISPopSci workshop in 2005 (UC Santa Barbara)

Publications

Books

M.F. Goodchild and D.G. Janelle, editors (2004) *Spatially Integrated Social Science*. New York: Oxford University Press.

D.G. Janelle, B. Warf, and K. Hansen, editors (2004) *WorldMinds: Geographical Perspectives on 100 Problems*. Commemorative publication for the Centennial of the Association of American Geographers. Dordrecht: Kluwer Academic.

Refereed journal articles and book chapters

M.-P. Kwan, D.G. Janelle, and M.F. Goodchild (2003) Accessibility in space and time: a theme in spatially integrated social science. *Journal of Geographical Systems* 5: 1–3.

D.G. Janelle (2003) Sustainable transportation and information technology: suggested research issues. In R Stough, Y Higano, K Button, and P Nijkamp, editors, *Transportation and Information Systems*. London: Edward Elgar Publishing Ltd.

D.G. Janelle (2005) Time–space modeling. In Kimberley Kempf-Leonard, editor, *Encyclopedia of Social Measurement.* San Diego: Academic Press, 3: 851–856.

B. Warf, D.G. Janelle, and K. Hansen (2004) Introducing *WorldMinds*. In D.G. Janelle, B. Warf, and K. Hansen, editors, *WorldMinds: Geographical Perspectives on 100 Problems*. Dordrecht: Kluwer Academic Publishers, xvii–xxii.

D.G. Janelle and A. Gillespie (2004) Space–time constructs for linking information and communication technologies with issues in sustainable transportation. *Transport Reviews* 24(6): 665–677.

D.G. Janelle (2004) Looking back and looking forward from 'The Geography of the United States in the Year 2000' to the Geography of the United States in 2030. *The Professional Geographer* 56: 81–84.

M. Goodchild and D.G. Janelle (2004) Thinking spatially in the social sciences. In M. Goodchild and D.G. Janelle, editors, *Spatially Integrated Social Science*. New York: Oxford University Press, 3–17.

D.G. Janelle (2004) Impact of information technologies. In S. Hanson and G. Giuliano, editors, *The Geography of Urban Transportation*. 3rd Edition. New York: Guilford Press, 86–112.

D.G. Janelle (2005) Transportation. In B. Feintuch and D. Watters, editors, *Encyclopedia of New England Culture*. New Haven: Yale University Press, 614–616.

D.G. Janelle (2006) Review of M. Beuthe, V. Himanen, A. Reggiani, and L Zamparini, eds. *Transport Developments and Innovations in an Evolving World* (Berlin: Springer, 2004). *Growth and Change: A Journal of Urban and Regional Policy* 36.

D.G. Janelle and M. Goodchild (2006) Spatially integrated social science. In B. Warf, editor, *Encyclopedia of Human Geography*. Thousand Oaks, CA: Sage Publications.

Non-refereed publications

D.G. Janelle (2004) *Spatial Social Science*. Santa Barbara: Center for Spatially Integrated Social Science, University of California, Santa Barbara.

Luc Anselin, PI for CSISS Tools Development

During the period May 2003–December 2005, my CSISS-related efforts have continued to be primarily related to the management of the software tools development unit at UIUC. This involves activities ranging from personnel management to software design, implementation, and testing. Related to this, I have made a number of presentations to various audiences about the CSISS software tools program as well as on specific methodological and software design issues.

The main activities this past period related to porting GeoDa to a cross-platform and open source-environment and the development of the PySAL library, the latter jointly with Sergio Rey at San Diego State University. In addition, an important focus was the creation of a series of support materials, tutorials, and manuals for the software.

I participated in the CSISS Specialist Meeting on Spatial Analysis and Health Risk Perception (Oct. 2003) and completed editing a volume on *Advances in Spatial Econometrics* (Springer-Verlag 2004), jointly with Raymond Florax (Purdue University) and Sergio Rey (SDSU). This volume is part of the CSISS Best Practice program. I continue to represent the CSISS programs in a number of conference presentations and short courses, including the annual meetings of the American Sociological Association.

Substantively, I continue to work with a number of collaborators at various universities on issues related to the incorporation of spatial interaction and spatial effects in social-science models. This includes ongoing work on the spatial patterning of homicides, with Steve Messner and Glenn Deane at SUNY Albany (chapter in Goodchild–Janelle *Spatially Integrated Social Science*, and article forthcoming in *Criminology*), and with Sanjeev Sridharan, now at the University of Edinburgh (article forthcoming in *Social Indicators Research*). I also continue the study of the sensitivity of impact measures of air quality to the type of space–time methodology that is employed (previously funded by NSF/EPA) jointly with James Murdoch (UT Dallas), Mark Thayer (San Diego State University), and Julie Le Gallo (University of Bordeaux).

Several new collaborations were started as well during this period. I work with Ann Bostrom at Georgia Tech on the visualization and communication of risk in decision-support systems related to earthquake hazards, in the context of the Mid-America Earthquake Institute (headquartered at UIUC and funded by NSF). I also collaborate with a group at Northwestern (Matzkin), the University of Chicago (Heckman), and Argonne National Laboratory (Boyd) on incorporating spatial effects in micro-models of economic behavior (funded by the NSF HSD program), and to enhance the spatial analytical capabilities of the US Census Research Data Centers. Finally, I work with Lee Mobley at Research Triangle International on models for spatial market areas of health service providers.

I continue to co-edit the *International Regional Science Review* and completed guest co-editing with Sergio Rey a special issue of the journal *Geographical Analysis*, resulting from the CSISS Specialist Meeting on Spatial Software Tools.

Presentations

The University at Albany, SUNY, Albany, NY, May 19–21, 2003: Short Course on "Spatial Data Analysis".

Environmental Systems Research Institute (ESRI), Redlands, CA, May 28, 2003: "Current Developments in Spatial Statistics Software"

START Advanced Institute on Urbanization, Emissions and the Global Carbon Cycle, National Center for Atmospheric Research (NCAR), Boulder, CO, August 7, 2003: "Exploratory Spatial Data Analysis and GeoDa" (short course)

American Sociological Association 2003 Annual Meeting, Atlanta, GA August 17–20, 2003: "Exploratory Spatial Data Analysis and GeoDa"

Keynote Address, Section on Methodology, American Sociological Association 2003 Annual Meeting, Atlanta, GA August 17–20, 2003: "Networks, Multipliers and

Spatial Externalities in Spatial Regression"

Modeling and GIS Workshop, Environmental Systems Research Institute, Redlands, CA, Sept. 25-26, 2003: "Spatial Statistical Modeling"

Specialist Meeting on Spatial Analysis and Health Risk Perception, Center for Spatially Integrated Social Science, Santa Barbara, CA, Oct. 10–11, 2003: Spatial Statistics and Health"

International Conference on Health Policy Research, American Statistical Association, Chicago, IL, Oct. 17–19, 2003: "New Software Tools for Spatial Econometric Analysis"

50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003: "GeoDa, An Introduction to Spatial Data Analysis"

50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003: "Regional Innovations in the U.S. over Space and Time"

50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003: "Exploration and Visualization of Space-Time Patterns in the Association between Health and Air Quality"

50th Annual North American Meetings of the Regional Science Association International, Philadelphia, PA, Nov. 20–22, 2003: "A Parallel Method for Maximum Likelihood Estimation of Models with Spatial Dependence"

Symposium on Spatial Information Science for Human and Social Science, University of Tokyo, Tokyo, Japan Jan 29–30, 2004: "Spatial Analytical Approaches to Concentration-Response Modeling, Methods and Tools"

100th Annual Meeting of the Association of American Geographers, Philadelphia, PA, March 14–18, 2004: "Exploring Spatial Data with GeoDa" (workshop)

100th Annual Meeting of the Association of American Geographers, Philadelphia, PA, March 14–18, 2004: "Panel Data Spatial Econometrics with PySpace"

Specialist Meeting on Prostate Cancer Geocoding, Assessing Fitness for Use, University of Iowa College of Public Health, Iowa City, IA March 31–April 2, 2004: "Exploring Spatial Clusters and Outliers in Prostate Cancer Rates"

Center for Urban and Regional Analysis Colloquium, The Ohio State University, Columbus, OH, Oct. 18, 2004: "Air Quality in Hedonic House Price Models: Spatial Aspects"

51st Annual North American Meetings of the Regional Science Association International, Seattle, WA, Nov. 10–13, 2004: "GeoDa and Beyond: ESDA and Flow Data"

51st Annual North American Meetings of the Regional Science Association International, Seattle, WA, Nov. 10–13, 2004: "Air Quality in Hedonic House Price Models: Spatial Aspects"

CDC Division of Cancer Prevention and Control, Geographic Information Science Research Priorities, Santa Barbara, CA, Nov. 17–18, 2004: "Some Thoughts on

Analysis/Statistical Issues"

Colloquium, Department of Geography, The Ohio State University, Columbus, OH, Jan. 6, 2005: "GeoDa: Why, How and What is Next"

Colloquium, Department of Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, MA, Feb. 4, 2005: "GeoDa, an Introduction to Spatial Data Analysis"

Annual Meeting of the Association of American Geographers, Denver, CO, April 5–9, 2005: "PySAL, a Python Library for Spatial Analytical Functions"

Seminar, Development Economics Research Group, The World Bank, Washington, DC: May 18, 2005: "Under the Hood: Issues in the Specification, Estimation and Implementation of Spatial Regression Models."

Environmental and Resource Economics Seminar, Development Economics Workshop, and Econometrics Seminar, Departments of Economics and Agricultural and Resource Economics, UC Davis, Davis, CA: June 6, 2005: "Air Quality in Hedonic House Price Models: Spatial Aspects."

University of Illinois, Urbana-Champaign, Urbana, IL, July 25–27, 2005: "Exploring Spatial Data with GeoDa" (short course)

GeoComputation 2005, 8th International Conference on GeoComputation, Ann Arbor, MI: July 31–Aug 3, 2005: "Exploring Spatial Data with GeoDa" (workshop)

GeoComputation 2005, 8th International Conference on GeoComputation, Ann Arbor, MI: July 31–Aug 3, 2005: "PySAL, a Python Library for Spatial Analytical Functions"

Inaugural Arthur Getis Lecture in Spatial Analysis, San Diego State University, San Diego, CA: October 7, 2005: "A Look at 25+ Years of Spatial Econometrics: Past, Present and Future."

52nd Annual North American Meetings of the Regional Science Association International, Las Vegas, NV, Nov. 10–12, 2005: "Clustering Components in the Python Spatial Analysis Library (PySAL)"

52nd Annual North American Meetings of the Regional Science Association International, Las Vegas, NV, Nov. 10-12, 2005: L. Anselin and N. Lozano "The Valuation of Environmental Disamenities in Spatial Hedonics House Price Models: An Empirical Comparison"

Publications

Journal special issues

S. Rey and L. Anselin, guest editors (2006) *Geographical Analysis* 38 (1), 2006: Special Issue on Software for Spatial Analysis in the Social Sciences

Books

L. Anselin, R. Florax, and S. Rey, editors (2004) *Advances in Spatial Econometrics. Methodology, Tools and Applications.* Berlin: Springer-Verlag.

Refereed journal articles

L. Anselin and R. Moreno (2003) Properties of tests for spatial error components. *Regional Science and Urban Economics* 33(5): 596–618.

L. Anselin, R. Bongiovanni, and J. Lowenberg-DeBoer (2004) A spatial econometric approach to the economics of site-specific nitrogen management in corn production. *American Journal of Agricultural Economics* 86(3): 675-687.

L. Anselin, Y-W Kim, and I. Syabri (2004) Web-based spatial analysis tools for the exploration of spatial data. *Journal of Geographical Systems* 6(2): 197–218.

L. Anselin (2006) How (not) to lie with spatial statistics. *American Journal of Preventive Medicine*.

L Anselin, I. Syabri, and Y. Kho (2006) GeoDa: an introduction to spatial data analysis. *Geographical Analysis* 38.

S. Rey and L. Anselin (2006) Recent advances in software for spatial analysis in the social sciences. *Geographical Analysis* 38.

L. Anselin, S. Sridharan, and S. Gholston (2006) Using exploratory spatial data analysis to leverage social indicator databases: the discovery of interesting patterns. *Social Indicators Research*.

S. Messner, G. Deane, L. Anselin, and B. Pearson-Nelson (2006) Locating the vanguard in rising and falling homicide rates among U.S. cities. *Criminology*.

Book chapters

L. Anselin (2003) Spatial regression. In M. Lewis-Beck, A. Bryman, and T.F. Liao, editors, *The Sage Encyclopedia of Social Science Research Methods*. Thousand Oaks, CA: Sage Publications, pp. 1050–1051.

S. Messner and L. Anselin (2004) Spatial analyses of homicide with areal data. In M. Goodchild and D. Janelle, editors, *Spatially Integrated Social Science*. New York: Oxford University Press, pp. 127–144.

L. Anselin, A. Getis, A. Lea, M. Ferguson, and H. Miller (2004) Spatial analysis and modeling in a GIS environment. In R. McMaster and L. Usery, editors, *A Research Agenda for Geographic Information Science*. Boca Raton: CRC Press, pp. 157–196.

L. Anselin, R.J.G.M. Florax, and S. Rey (2004) Econometrics for spatial models, recent advances. In L. Anselin, R. Florax, and S. Rey, editors, *Advances in Spatial Econometrics: Methodology, Tools and Applications*. Berlin: Springer-Verlag, pp. 1–25.

L. Anselin (2005) Spatial statistical modeling in a GIS environment. In D. Maguire, M. Goodchild, and M. Batty, editors, *GIS, Spatial Analysis and Modeling*. Redlands, CA: ESRI Press, pp. 93–111.

L. Anselin (2006) Spatial econometrics. In T.C. Mills and K. Patterson, editors, *Palgrave Handbook of Econometrics: Volume 1, Econometric Theory*. Basingstoke: Palgrave Macmillan.

L. Anselin, J. Le Gallo, and H. Jayet (2006) Spatial panel econometrics. In L. Matyas and P. Sevestre, editors, *The Econometrics of Panel Data, Fundamentals and Recent Developments in Theory and Practice* (3rd Edition). Dordrecht: Kluwer.

Richard Appelbaum

My research examines global commodity chains, focusing in particular on the locational determinants of labor-intensive low-wage production, and its impacts on industrial upgrading as well as economic inequality. One key aspect of this work is the spatial distribution of production sites, the formation of industrial districts. I am especially concerned with the global regulation and enforcement of labor standards, particularly with regard to apparel production. Another aspect concerns the ways in which national economies "move up" the commodity chain into higher value-added activities, and the extent to which such movement can translate into economic development. The article "Governance and Flexibility: The East Asian Garment Industry" examines this questions with reference to the role of apparel production in economic development in the region.

In this regard I chair the Advisory Council of the Worker Rights Consortium, a national organization comprised of 147 colleges and universities, as well as labor unions, student groups, and NGOs concerned with implementing university codes of conduct that regulate trademark licensing. I also served as a member of the University of California's System-wide Committee on Trademark Licensing, in the Office of the President. Honors section students in my undergraduate Introduction to Global Studies class wrote a Code of Conduct for Santa Barbara County, which was unanimously adopted by the county Board of Supervisors.

My co-authored book *Behind the Label: Inequality in the Los Angeles Apparel Industry* (with Edna Bonacich, University of California Press, 2000) was selected by the *Los Angeles Times* as one of the best non-fiction books of 2000, was a finalist for the annual C. Wright Mills Award of the Society for the Study of Social Problems in 2001, and won the ASA Marxist Section book award in that year. The book was the subject of a Presidential Session of the Pacific Sociological Association and the American Sociological Association in 2001.

My work is situated within the world-systems framework, which seeks to understand cycles of economic growth and decline within the global economy. (I served as president of the American Sociological Association's Political Economy of the World-System section.) Much of my work examines low-wage labor in highly globalized industries, examining labor standards and their enforcement. *Behind the Label* examined the factors which enabled Los Angeles to remain a center of garment production in the face of globalizing forces. The downtown fashion center remains a vital industrial district, with thousands of small contracting factories, buying offices that provide services for the country's principal retailers, fashion schools, fabric providers, and numerous other providers of apparel-related goods and services, enabling the industry to provide extremely quick turnaround of small batch production, giving it a vital edge over other regions (and other countries) in the production of fashionable items. The spatial

contiguity of numerous actors in the fashion industry acquires special symbolic significance in Los Angeles, where image is all-important: Los Angeles is a center of fashion design thanks in large part to the entertainment industry (movies, television, and music) and the image of the California lifestyle it connotes. Nonetheless, the industry has lost ground initially to Mexico (since NAFTA), and now China. Understanding such respatialization of production represents a significant challenge.

A related aspect of my work concerns the development of legal regimes to regulate increasingly global businesses. *Rules and Networks: The Legal Culture of Global Business Transactions*, a co-authored edited volume that grew out of a conference held at the Oñati International Institute for the Sociology of Law (published 2001 by Hart Publishers in Oxford) reflects this concern. The book is based on the premise that international business transactions are heavily influenced by culture, practice, and rule. The construction and fate of business relationships within a nation-state may encounter differences in the generation of norms and the processing of disputes, but these conflicts are magnified many times over in cross-border transactions where nation-state control and support is weak or absent. The book seeks different explanations of the ways in which business people and their legal advisers try to minimize the effect of these magnified difficulties. Since most explanations are dominated by North American and European legal scholarship and practice, a second concern of the book is to open up the discussion to competing explanatory frameworks. Specifically, the book advances the idea that global legal convergence may not be the immediate, inevitable result of increased global economic interaction. Rather, less formal mechanisms for achieving normative understanding and predictability in business dealings may also flourish. These include four possible sources through which the international business community might be considered to have supplemented nation-state conflict prevention and dispute resolution institutions—an international legal order, the development of a private normative order based on common business practices (denominated the *lex mercatoria*), through the efforts and work product of internationalized law firms, and by means of extensive, thick personal relationships often referred to by their Chinese term guanxi).

My largest concerns are with the broad processes of globalization, and the centrifugal forces that dispersed production and globalize commodity chains—the respatialization of the world economy. My 2004 co-authored book (with William Robinson), *Critical Globalization Studies*, is the first book to map out a *critical* approach to the rapidly growing field of globalization studies. Centrally concerned with global justice, the volume serves as a bridge connecting scholars of globalization, the policy world, and the global justice movement. The essays examine a wide range of topics too often left at the margin of globalization studies and in the process raise a host of crucial questions: What is a critical globalization studies? What are the competing approaches and perspectives within the globalization debate? What is the nature of power and conflict in the world today and what role does globalization play? In what directions is globalization research moving and what are the implications of globalization for the academy? How have major global resistance movements affected the study of globalization?

The monograph *TNCs and the Removal of Textiles and Clothing Quotas* (2005), written for the United Nations Conference on Trade and Development (UNCTAD), examines the

global respatialization of production in textiles and apparel following the elimination of quotas on January 1, 2005. Drawing on a wide range of studies as well as on original research, the report shows that transnational corporations (TNCs) are likely to play a critical role in determining the future global production structure in these industries. First, the sourcing strategies of a small number of very large retailing companies (based in the United States, Europe, and Japan) place stringent requirements on the locations in which textiles and clothing will be produced. Second, the investment strategies of large transnational producers (mostly based in East Asia) will also affect the final outcome. The removal of quotas generally means intensified competition for foreign direct investment in textiles and clothing. To become or stay competitive as host locations, countries will need to develop their ability to move away from simple assembly to "full-package" production and eventually original brand manufacture. China, which possesses many advantages, is predicted to account for as much as half of global exports in these industries within a few years, with potentially highly adverse impacts on the economies of a number of countries in South Asia, Latin America, and Africa that have become highly dependent on textile and apparel exports.

Finally, I am a principal in a newly-funded National Science Foundation Nanoscale Science and Engineering Center (NSEC), UCSB's Center for Nanotechnology in Society. The CNS (http://www.cns.ucsb.edu) serves as a national research and education center, a network hub among researchers and educators concerned with nanotechnologies' societal impacts, and a resource base for studying these impacts in the US and abroad. It will carry out innovative and interdisciplinary research in three key areas: the historical context of nanotechnologies; the institutional and industrial processes of technological innovation of nanotechnologies along with their global diffusion and comparative impacts; and the social risk perception and response to different applications of nanotechnologies.

Presentations

"Global Production and the Rise of Demand-Responsive Economies Marketing, Merchandising, and Retailing," Sloan Workshop Series in Industry Studies on The Role of Intermediaries in Global Value Chains, University of Washington (June 7, 2004)

"The World After (Textile/Apparel) Quotas," presentation and briefing before the State Department's Bureau of Intelligence and Research (INR), Washington, D.C. (May 21, 2004)

"Can Multinationals Be Challenged? Fighting Sweatshops in the Global Economy," Urban and Global Studies Program, University of Southern California (April 1, 2004)

"The Flowering of the Corporations," presentation at Green Party Public Forum, Santa Barbara (March 16, 2004)

"The Truth Behind the War in Iraq," panel discussion, Campbell Hall, UCSB (March 9, 2004)

"Teaching Global Studies," panel discussion with Mary Kaldor (LSE) and others, America and the Reshaping of a New World Order series, UCSB (February 27, 2004)

"What Students Can Do in Fighting Sweatshop Production," plenary presentation at United Students Againast Sweatshops Annual Conference, Atlanta, Georgia (February 13, 2004)

"Commodity Chains and Economic Development: One and a Half Proposals for Spatially-Oriented Research" , conference on *Time-Mapping Globalization in the World-System*, University of California-Riverside Institute for Research on World-Systems (February 7, 2004)

"Fighting Sweatshops: Problems of Enforcing Global Labor Standards," presentation at Bowdoin College Common Hour (November 14, 2004)

Publications

Books

R.P. Appelbaum (2005) *TNCs and the Removal of Textiles and Clothing Quotas*. Geneva, Switzerland: UNCTAD

R.P. Appelbaum and W.I. Robinson, editors (2004) *Critical Globalization Studies*. NY: Routledge.

R.P. Appelbaum, editor (2004) *Introduction to Global Studies: Politics and Economics*. Dubuque, IA: Kendall Hunt.

Articles in books

R.P. Appelbaum and W.I. Robinson (2004) Towards a critical globalization studies: continued debates, new directions, neglected topics. I R.P. Appelbaum and W.I. Robinson, editors, *Critical Globalization Studies*. New York: Routledge.

R.P. Appelbaum (2004) Fighting sweatshops: problems of enforcing global labor standards. In R.P. Appelbaum and W.I. Robinson, editors, *Critical Globalization Studies*. New York: Routledge.

Other publications

R.P. Appelbaum and P. Dreier (2005) Students confront sweatshops. *The Nation* (November 28)

R.P. Appelbaum and P. Dreier (2004) SweatX closes up shop. *The Nation* (July 19-26): 6–8.

Barbara Herr Harthorn

Barbara Herr Harthorn is Co-Director of the new Nanoscale Science and Engineering Center: Center for Nanotechnology in Society-UCSB, Associate Director of the Institute for Social, Behavioral, and Economic Research at UC Santa Barbara, and Associate Research Anthropologist. She also serves as director of Social Science Research Development for the UC Santa Barbara campus. Her work as leader of an interdisciplinary research group (IRG) in the new CNS-UCSB examines societal

perceptions of the risks of nanotechnologies and their spatial dimensions. This is one aspect of her work on the social production of gender and ethnic disparities in health, which has included studies of immigrant health in California, present and past, and Anglo and Latino community health at the interface of urban and rural agricultural sectors. Her research has focused on maternal health, reproduction, living and working conditions, and tuberculosis treatment among Santa Barbara County female and male farmworkers, including farmworker perceptions of risks related to exposure to agricultural chemicals and the spatial dimensions of risk. In 2003 she hosted a specialist meeting at UCSB to explore the possibilities for applying spatial analytic methods to the study of health risk perception. This has led to the development of an international network of researchers interested in this new area of research, a collaborative proposal to the National Cancer Institute on which Dr. Herr Harthorn was lead PI, and now to the successful NSEC:CNS-UCSB award, in which she has a central role.

Presentations

"Risk, Culture, and Landscape: Multiple-Party Representations of Perceived Risk". Terre Satterfield, UBC, and B. Herr Harthorn, Co-Organizers, Co-Chairs, Invited panel of the Society for Applied Anthropology, Santa Fe, April 5–10, 2004.

"Multifactorial Mapping of Risk Perception, Risk Factors, and Risk Protective Factors", Paper in panel, "Risk, Culture, and Landscape: Multiple-Party Representations of Perceived Risk, organized by T Satterfield and B. Herr Harthorn, Society for Applied Anthropology April 5–10, 2004.

"Intersections of Risk and Culture in Health and Environment, I and II" Co-Chair, Co-Organizer, panel of the Society for Medical Anthropology, at the annual meetings of the Society for Applied Anthropology, Dallas, Mar 31–Apr 4, 2004.

"Locating Health Risk Perception in Cultural Space," paper presented in the panel "Intersections of Risk and Culture in Health and Environment, I and II" organized by T. Satterfield and B. Herr Harthorn at the annual meetings of the Society for Applied Anthropology, Dallas, Mar 31–Apr 4, 2004.

"Unstable Terrain: Agency and Constraint Experienced by California Farmworkers over Reproductive Health Care, Tuberculosis Treatment, and Chemical Exposure Diagnosis". Paper presented at the American Anthropological Association meetings, Nov 19–23, 2003, Chicago, in the panel "Rethinking Pragmatism".

"Producing Inequality: Public Health's Response to Latino Immigrants with Tuberculosis, Past and Present." Paper presented in a panel on "Health Care for Latinos" at the Society for Applied Anthropology meetings, March 19–23, 2003, Portland, Oregon.

Publications

Books

B.H. Harthorn and L. Oaks, editors (2003) *Risk, Culture, and Health Inequality: Shifting Perceptions of Danger and Blame*. New York: Greenwood/Praeger.

Articles in books

B.H. Harthorn (2003) Safe exposure? Perceptions of risks from agricultural chemicals among California farmworkers. In B.H. Harthorn and L. Oaks, editors, *Risk, Culture, and Health Inequality: Shifting Perceptions of Danger and Blame*. New York: Greenwood/Praeger, pp. 143–164

L. Oaks and B.H. Harthorn (2003) Health and the Social and Cultural Construction of Risk. In B.H. Harthorn and L. Oaks, editors, *Risk, Culture, and Health Inequality: Shifting Perceptions of Danger and Blame*. New York:Greenwood/ Praeger. pp. 3–12.

Helen Couclelis

By its nature, my ongoing research on urban modeling and planning and on the geography of the information society is cross disciplinary, at least across the social sciences. My recent writings and other activities have involved insights from economics, sociology, health science, the decision sciences, psychology, linguistics, and computer science, while highlighting geography's strong spatial perspective. In that sense, my work helps promote the CSISS goal of cultivating an integrated approach to social science research that recognizes the importance of location, space, spatiality, and place.

The publications and other items listed in the following are all related to CSISS objectives. The 2004 paper in *Cartographica* is based on my personal observations of the first two CSISS Specialist Meetings (Inequality & Equity and Spatial Externalities). I was a participant in both meetings and co-organizer of the first.

Presentations

"Understanding space-time dynamics in the age of ICT: proposal for a framework". STELLA Focus Group 2 Synthesis meeting on *'ICT, Innovation and the Transport System'*. Budapest, Hungary, April 2004.

"Rethinking time geography in the age of ICT". International specialist meeting on *ICT, Everyday Life and Urban Change*. Doorn, The Netherlands, November, 2004.

"Globalization studies: one globe, many spaces". GLOBGIS Symposium, UC Riverside, Riverside, CA, February 2004.

"Steps towards a framework for integrating cellular automata and agent-based models". *Association of American Geographers Annual Meeting*, Philadelphia, PA, March 2004.

"Events don't happen 'just so': representing geographic change in a purposeful world". *GIScience '04,* Adelphi, MD, October 2004.

"Beyond data layers: representing agency, purpose and change in GIS". *Colloque International de Geomatique et d'Analyse Spatiale (SAGEO 2005)* Avignon, France – June 2005.

Publications

Refereeed journal articles

H. Couclelis (2003) Housing and the new geography of accessibility in the information age. *Open House International,* theme issue on "ICT, Housing & the Built Environment", 28(4): 7–13

H. Couclelis (2004) The construction of the digital city. *Environment and Planning B* 31(1): 5–19.

H. Couclelis (2004) Pizza over the Internet: e-commerce, the fragmentation of activity, and the tyranny of the region. *Entrepreneurship & Regional Development* 16(1): 41–54

H. Couclelis (2004) The third domain: The spread and use of GIS within social science. *Cartographica* 39(1): 17–24.

M. Herold, H. Couclelis, and K. Clarke (2005) The role of spatial metrics in the analysis and modeling of urban growth and land use change. *Computers, Environment and Urban Systems* 29(4): 369–399.

H. Couclelis (2005) "Where has the future gone?" Rethinking the role of integrated land use models in spatial planning. *Environment and Planning A* 37(8): 1353–1371.

Articles in refereed conference proceedings

J. Howarth and H. Couclelis (2005) A linguistics-based framework for modeling spatio-temporal occurrences and purposive change. In D. Mark and A. Cohn, editors, *Proceedings of the Seventh International Conference in Spatial Information Theory: COSIT '05, Conference in Spatial Information Theory*. Berlin: Springer.

Peter J. Kuhn

Since mid-2003, my published research has focused on a number of areas in labor economics. Of these, the area most closely integrated with my involvement in CSISS considers the effects of the Internet on the job search process (for example, does it reduce the influence of geography by facilitating long-distance job matches?). During the period, in addition to a number of other publications, I published an article on internet job search in the *American Economic Review*, and contributed a chapter on Internet job search to the *New Economy Handbook*. I also made 21 presentations on a variety of topics, at venues including Princeton, Stanford, Berkeley, and a number of international destinations. I served on the Advisory Board of the UCSB/Penn State GIS Population Science Program. In 2005 I became a Research Associate of the National Bureau of Economic Research, the nation's leading economic research institute.

Publications

Refereed journal articles

P.J. Kuhn and M. Skuterud (2004) Internet job search and unemployment durations. *American Economic Review* 94(1): 218–232.

P.J. Kuhn and S. Johnson (2004) Increasing male earnings inequality in Canada and the U.S., 1981–1997: the role of hours changes versus wage changes. *Canadian Public Policy* 30(3): 155–175.

P.J. Kuhn (2004) Is monopsony the right way to model labor markets? A review of Alan Manning's *Monopsony in Motion*. *International Journal of the Economics of Business* 11(3): 369–378.

P.J. Kuhn and C. Weinberger (2005) Leadership skills and wages. *Journal of Labor Economics* 23(3): 395–436.

Books

P.J. Kuhn and G. Marquez, editors (2005) *The Economic Effects of Labor Unions in Latin America*. Washington, DC: Inter-American Development Bank.

Articles in books

P.J. Kuhn (2003) The new economy and matching in labor markets. In Derek Jones, editor, *New Economy Handbook*. Amsterdam: Academic Press, pp. 508–523.

P.J. Kuhn (2005) Comment (on *Innovation and Response in Industrial Relations and Workplace Practices under Increased Canada–U.S. Economic Integration* by R. Chaykowski and G. Slotsve). In R.G. Harris and T. Lemieux, editors, *Social and Labour Market Aspects of North American Linkages*. Calgary, Alberta: University of Calgary Press, pp. 286–293.

Stuart Sweeney

Since 2003, my research and outreach activities have continued to support the general goals of CSISS. My research papers listed below focus on the development and extension of spatial statistical methods with applications in the social sciences. The research has been supported by grants from the National Science Foundation and well as other local sources.

In addition to presenting my research at conferences, I have also given several presentation that are specifically geared towards CSISS outreach. My activities for the NSF-funded SPACE workshops have been in more of a leadership role. In addition to giving several lectures at the workshops, I have been the workshop coordinator for those at UCSB. Over the past year I have also been the Chair of a graduate emphasis, Quantitative Methods in the Social Sciences, which has allowed me to bring several GIScience speakers to campus colloquia.

Presentations

"Small area population projections using stochastic simulation." Annual Meeting, Population Association of America, 2003.

"Modeling spatial-temporal structures in migration systems," North American Meetings of the Regional Science Association International, 2003.

"Population distribution from remote sensing," Invited Session Chair, Conference on Migration, Urbanization, and Health: The Role of Remote Sensing and Geographic Information Systems for Monitoring, Surveillance, and Program Evaluation, Princeton University, 2004.

"Sub-district enrollment projections using student level records," Annual Meeting, Population Association of America, 2004.

"Space-time analysis of industry concentration." Western Regional Science Association, 2004.

"Modeling spatial-temporal structures in migration systems: Towards integrated analysis and visualization of transaction data." Invited Colloquium Speaker, Department of Geography, San Diego State University, 2004.

"Parameter-constrained models of space-time migration structure." Invited Lecture, UI Regional Science Lecturer, University of Illinois, Urbana-Champaign, September 2005.

"Integrating GIS and spatial analysis into the planning curriculum: An overview of CSISS/SPACE." Invited Lecture, Association of Collegiate Schools of Planning, 46th Annual Conference, Kansas City, MO, October 2005.

"Spatial analysis in the planning curriculum: Concepts and tools." Invited Lecture, Association of Collegiate Schools of Planning, 46th Annual Conference, Kansas City, MO, October 2005.

Publications

Refereed journal articles

S. Sweeney (2004) Regional occupational employment projections: Modeling supply constraints in the direct-requirements approach. *Journal of Regional Science* 44(2): 263–288.

S. Sweeney and K. Konty (2005) Robust point pattern inference from spatially censored data. *Environment and Planning A* 37(1): 141–159.

E. Feser, S. Sweeney, and H. Renski (2005) A descriptive analysis of discrete U.S. industrial complexes. *Journal of Regional Science* 45(2): 395–419.

S. Sweeney and H. Goldstein (2005) Accounting for migration in regional occupational employment projections. *Annals of Regional Science* 39 (2): 297–316.

S. Sweeney and E. Middleton (2005) Multiregional cohort enrollment projections: Matching methods to enrollment policies. *Population, Place, and Space* 11: 361–379.

E. Feser and S. Sweeney (2005) On the state of the geography in the U.S. BLS-covered wages and employment (ES-202) series. *International Regional Science Review*.