Accessibility in space and time:
A theme in spatially integrated social science

Mei-Po Kwan[1], Donald G. Janelle[2], Michael F. Goodchild[3]

[1] Department of Geography, The Ohio State University, 1036 Derby Hall, 154 North Oval Mall, Columbus, OH 43210-1361, USA (e-mail: kwan.8@osu.edu)
[2] Center for Spatially Integrated Social Science, University of California, Santa Barbara, California 93106-4060, USA (e-mail: janelle@geog.ucsb.edu)
[3] Center for Spatially Integrated Social Science, and Department of Geography, University of California, Santa Barbara, California 93106-4060, USA (e-mail: good@ncgia.ucsb.edu)

The analysis of space and place has become an increasingly important component of social science research in the past two decades (Goodchild et al. 2000). This is mainly due to recent advances in spatial technologies (especially GIS), the availability of a massive amount of geocoded data, and the recognition that space can be a powerful integrating framework for social science disciplines. In light of the growing significance of space, location, and place in social science research, and based upon the vision that a spatial approach provides a compelling integrating framework for the social sciences, the Center for Spatially Integrated Social Science (CSISS) was established to develop unrestricted access to tools and perspectives that will advance the spatial analytic capabilities of researchers throughout the social sciences.[1]

CSISS is funded by the National Science Foundation (USA) under its program of support for infrastructure in the social and behavioral sciences. It focuses on spatial analysis as an integrating force for the social sciences and seeks to achieve its goals through six interrelated programs: learning resources, workshops, best-practice publications, place-based search methodologies, software tools development, and a virtual community (e.g. Goodchild and Janelle 2003). These programs are informed by recent advances in spatial information science, and are designed to provide infrastructure to facilitate the national dissemination of spatial perspectives across the social science disciplines.

The contributors of this special issue of the *Journal of Geographical Systems* were the instructors of the CSISS workshop on *Accessibility in Space and Time: A GIS Approach*, held at the Ohio State University in July 2002. As part of the CSISS program, the workshop is based upon the premise that concepts and methods for analyzing accessibility are essential for understanding many significant social, economic, and political issues (e.g., access to jobs, healthcare, transportation, and other public facilities for different

---

[1] Details about CSISS programs and substantive collections of resources are available at http://www.csiss.org/

population subgroups). Geared to an audience of junior faculty and graduate students, the workshop was conducted as a series of lectures and related hands-on exercises covering topics such as network approaches, time-geographic perspectives, spatial optimization techniques, and spatial inter-action modeling of accessibility. It focuses on various spatial perspectives that can be applied to important societal questions in physical, social, or cyber-space.

The purpose of this special issue of the journal is to highlight recent approaches to GIS-based accessibility research as examples of spatially integrated social science. It contains six main articles that present results of the authors' original research, and a concluding article that discusses recent advances and future prospects of accessibility research. These articles were solicited by the managing guest editor, Mei-Po Kwan. Each was refereed and each author was asked to make any necessary revisions.

The first two articles deal with gravity-based accessibility and spatial interaction models. O'Kelly (Ohio State) and Horner (Southwest Texas State) conceive accessibility as the relative potential of give location and examine properties of exponential based accessibility formulations in detail. They apply accessibility indices to newly released county level census data to discern trends in the US population distribution. Their study shows that certain regions of the US, particularly the 'sun-belt' areas, continue to be high-growth areas, while other US regions have lost population over the last decade (e.g. the plains states and Appalachia). Tiefelsdorf (Ohio State) addresses the spatial structure effects of general interaction models through an exclusively statistical approach. He shows that the spatial heterogeneity in the estimated region-specific distance decay parameters may be due partly to a functional mis-specification of the global distance decay relationship, and partly to the heterogeneity in the region-specific conditional distance distributions. The study concludes that a proper specification of the global distance decay relationship is of paramount importance in interaction modeling and for accessibility studies.

The next two articles focus on space-time accessibility measures and algorithms. Weber (Alabama) examines the importance of distance from major employment centers as an explanatory variable for individual accessibility patterns within cities. He implemented a series of space-time accessibility measures using a GIS-based algorithm. Applying multilevel models on a large activity-travel diary data set collected in Portland, Oregon, he shows that the relationship between distance and access is more complicated than assessing the proximity of a person's home or work locations to the opportunities in an urban environment. Kim and Kwan (Ohio State) enhance space-time accessibility measures through a new geocomputational algorithm that better represents the space-time character-istics of urban opportunities, human activity-travel behavior (e.g. minimum activity participation time), and the effect of transport network topology (e.g. one-way streets). Their study shows that space-time measures that do not consider these complexities tend to over-estimate individual accessibility.

Two subsequent articles address accessibility issues through coverage models and choice modeling. Murray and Wu (Ohio State) propose two new approaches for modeling accessibility tradeoffs in transit route design: the distance constrained p-median problem (DCPMP) and the route

directed-distance constrained p-median problem (RD-DCPMP). Both approaches seek to reduce the current number of stops in order to promote faster transit speeds and greater geographic coverage given a travel time budget. They conclude that it may be possible to improve performance while ensuring suitable access to those currently served. Casas (SUNY-Buffalo) examines the effect of accessibility on individuals' response to traffic delays using data collected by a GIS-based travel simulator. The simulator generates scenarios in which the subject encounters unexpected traffic delays and is asked to make choices among several alternatives (e.g. taking an alternative route). Analysis using CHAID technique found that accessibility is a good predictor of subjects' choice when responding to unexpected traffic delays.

These papers together illustrate various spatial analytical methods that can be used to find solutions for real-world accessibility problems. The concluding article, by Kwan, Murray, O'Kelly and Tiefelsdorf (Ohio State), reflects on recent advances in accessibility research and their implications for future studies. It provides a highly selective discussion on some of the recent developments in accessibility research in terms of three intersecting dimensions: representation, methodology and applications. The research questions that arise from this special issue and those highlighted in the concluding article provide a helpful basis for addressing accurate representation, improved model building, and more rigorous applications in accessibility research.

References

Goodchild MF, Anselin L, Appelbaum RP, Herr-Harthorn B (2000) Toward spatially integrated social science. *International Regional Science Review* 23(2):139–159

Goodchild MF, Janelle DG (eds) (2003) *Spatially integrated social science*. Oxford University Press, New York