

## GIS AND SOCIETY

### Objective

As geographic information systems (GISs) become almost routine practice in the management, analysis and display technology of spatial data, their impact on society extends in many dimensions. A GIS allows efficient and flexible storage, display, and exchange of certain kinds of spatial data, as well as potential interface opportunities for a variety of quantitative spatial analysis models. GISs are used extensively in applications such as land parcel and land-use mapping for tax assessment and urban planning purposes. Networks are mapped in transportation analysis for traffic and transit management and determining efficient transportation routes for deliveries and emergency response and also by utility companies for gas, water, electricity and communications network management. Businesses apply geodemographic analysis to problems of facilities location and marketing and natural resource applications abound for inventory assessment and monitoring, harvest management, and conservation practices, for example water quality assessment and wildlife habitat studies. More recently GIS is playing a regular role in areas as diverse as public health surveillance and precision agriculture. In this wide range of applications users include private firms and individuals, national, regional and local governments and their agencies, non-profit organizations, grassroots and community groups, universities, and research institutes.

Yet, like all technologies, geographic information systems co-evolve with the societies of which they are a part. The overarching concern in the societal use of GIS is how this technology will influence – and be influenced by – the structures of society. What influences GIS adoption, development and use within different societal contexts? In what ways is GIS shaping society and, in turn, in what ways is GIS being shaped by society, - and by which segments of society? Many people view access to geographic information technology as a key for improving the quality of life. Conversely, many also see issues such as differential access to the technology and its products and the preservation of individual privacy as potential problems (Onsrud, Johnson and Lopez, 1994).

Consequently research in this field addresses three broad sets of questions: how GIS and its uses are diffusing in time and space; how the spread of GIS technology affects the political, economic, legal, and institutional structures of society; and how societal process affect the form taken by the technology itself. In the last two years, these topics have become central to GIS research, becoming one of three areas in which the NCGIA is encouraging new research initiatives, and gaining rapidly increasing attention by researchers and users. Thus research addressing the inter-relationships between GIS and society will, of necessity, often be a component of other GIS research, programmatically and at the project level, and also of more general research into the relationship between new information technologies and society. In spite of the cross-cutting nature with other UCGIS research themes, direct attention to this relationship is also important. This white paper seeks to lay out a series of research challenges focusing on the topic of GIS and

society and that specifically address those aspects which distinguish GIS from other information technologies.

## Background

The theme of GIS and society has been addressed from a number of theoretical and methodological approaches wherein certain focuses have received considerable visibility in the literature, while other perspectives on GIS in society are deserving of increased attention. Investigations into the status of GIS in society and the mutual influences between GIS and society have been enriched by insights coming from a range of approaches addressing a variety of topics. An important philosophical debate subtends the types of questions and problems raised by different members of the research community (Pickles, 1997; Wright et al., 1997). This debate, all too often cast as one between practitioners of the scientific method and those who choose alternative approaches, has been the source of many insights and new research directions. The creative tension generated in this discourse promises to stimulate further progress. One constructive result has been the aforementioned recognition of the necessity and value of a range of approaches and multiple perspectives in the study of GIS and society. Another is the explicit need for further research embodying intensive and extensive, and quantitative and qualitative methodologies, including, but not limited to, hypothesis testing, survey research, case studies and ethnographic approaches. Still further are calls within the academic community to explicate the philosophical and theoretical underpinnings of GIS. The following broad grouping of topics serves to illustrate the major research trends:

One set of themes and questions addresses the status and magnitude of GIS implementation by public and private institutions and the rates of adoption and participation across society. The costs and benefits associated with implementation are assessed, and the equity of the distribution of these costs and benefits determined among individuals and social groups. Theories, tools and techniques are continuing to develop for determining the impact of GIS on policy decisions and on expectations about the agencies implementing them. The impact of GIS on interactions between agencies, on citizens relationships with government agencies is evaluated, along with people's beliefs and actions in regard to the use and management of land and resources (Kishor et al. 1990; Epstein et al. 1996; Tulloch and Neimann, 1996; Ventura 1995).

A legal and ethical perspective is concerned with the changing institutional processes and pricing mechanisms governing access to spatial data; with the proliferation of proprietary spatial databases. Additionally this perspective addresses how these changes are rooted in governmental and legal regulation, and is concerned with the ethical implications of these changes; and with possible legal remedies (Chrisman, 1987; Curry, 1997; Onsrud and Rushton, 1995).

An intellectual history perspective addresses the evolution of geographic information technologies and the dynamics through which dominant technologies are selected from a variety of potential geographic information technologies at critical points in time. It is interested in revealing the societal, institutional and personal influences governing these selection processes and with the question of whether and why productive alternative technologies have been overlooked (Chrisman, 1988; Foresman, 1998; Mark, 1997).

A critical social theory perspective examines limitations in the ways that populations, location conflicts, and natural resources are represented within GIS and the extent to which these limits can be overcome by extending the possibilities of geographic information technologies. The critique emphasizes the ways in which the nature of and access to GIS simultaneously marginalize and empower different groups in society with overlapping or opposing interests. Furthermore, questions are raised of how the evolution of geographic information technologies reflects both societal structures and priorities as well as the practices of those who develop and utilize the technologies (Chrisman, 1987; Harris and Weiner, 1996; Harris and Weiner, 1998; Pickles, 1995; Poiker and Sheppard, 1995).

A public participation GIS perspective studies how a broader effective use of GIS by the general public and by community and grassroots groups can be attained. Public participation has implications for empowerment within such groups using GIS and with how new geographic technologies can be developed which address problems arising from the use of current GIS technologies in these contexts (Schroeder, 1997).

This brief survey of current directions illustrates how existing research amounts to a broad variety of conceptual and methodological approaches designed to assess how certain propositions about GIS and society apply in general or in particular contexts. This breadth reflects the complexity of the questions raised and the fact that many of them are not fully tractable using quantitative modes of analysis. Yet, notwithstanding this breadth, many questions have received inadequate attention, and others which have received attention are still in the early stages of understanding.

### The UCGIS Approach

The University Consortium for Geographic Information Science (UCGIS) seeks to facilitate a broad interest and involvement in GIS and society research. Research on GIS and society requires insightful contributions from economists, political scientists ethics, and legal studies and psychologists and other social scientists in addition to the main contributory disciplines such as geography, planning, policy analysis, geomatics, and computer science. A cross-disciplinary discourse is needed to elucidate the breadth of this research field. Those who understand human cognition and perception; those who understand the means by which cultural and natural spaces can be or should be represented; and those who use this information for social, political, legal, economic

purposes, as well as the resolution of disputes, should work together to understand future social ramifications of GIS. The University Consortium for Geographic Information Science (UCGIS) should be at the forefront of this agenda. UCGIS needs to facilitate interest and involvement in the topic of GIS and society research by diverse disciplines. Without a complete, multifaceted understanding of the consequences of GIS use, much money and effort may be wasted on technology and good intentions that result in limited benefits.

In its first white paper on 'GIS and society,' UCGIS proposed the following research priorities, developed, in part, from issues proposed at a 1995 specialist meeting sponsored by the National Center for Geographic Information and Analysis (Harris and Weiner 1996):

In what ways have particular logics and visualization techniques, value systems, forms of reasoning, and ways of understanding the world been incorporated into existing GIS techniques, and in what ways do alternative forms of representation remain to be explored and incorporated?

How has the proliferation and dissemination of databases associated with GIS, as well as differential access to these databases, influenced the ability of different social groups to utilize this information for their own empowerment?

How can the knowledge, needs, desires, and hopes of non-involved social groups adequately be represented as input in a decision-making process, and what are the possibilities and limitations of GIS technology as a way of encoding and using such representations?

What possibilities and limitations are associated with using GIS as a participatory tool for democratic resolution of social and environmental conflicts? What implications does research on the relationship between GIS and society reveal with regard to the types of ethical and legal restrictions that should be placed on access to and use of GIS?

This first set of UCGIS priorities does not exhaust the possible approaches to GIS and society and call for revision. An argument can be made that many of the questions posed above about GIS and society cannot be answered definitively until certain fundamental baseline research into the status of the technology has been completed. Users outside government and academia are poorly represented in the literature and the tone of the issues and a lack of engagement between GIS and society research and the private sector is evident. Economic efficiency and effectiveness are primary concerns in both contemporary business and government and comprehensive methods for estimating the full range of costs and benefits of GIS should be considered in spite of the difficulties inherent in measuring value. Additionally, the ways in which geographic information

technology is fundamentally different from other information technology is an essential question that must be placed in its societal context.

Based on an assessment of research reported during the last two years, the earlier priorities need to be modified to make sure that

- (i) sufficient studies of the magnitude and rate of use of GIS are available to demonstrate the levels of effectiveness and efficiency of its applications in local, national and international contexts for both public and private sectors
- (ii) attention given to the influence of GIS on society is counterbalanced by attention to the influence of society on the evolution of geographic information technologies;
- (iii) attention to the determinants and consequences of the broadening use of GIS in public agencies and institutions is balanced by the study of their use by private firms and by community and grassroots groups; and
- (iv) attention to empirical questions regarding the societal determinants and consequences of GIS is counterbalanced by attention to ethical and legal implications.

Examples of research questions prompted by these four themes are developed in the following section.

#### Importance to National Research Needs

Basic research into the relationship between GIS and society is of significance to the national research agenda for a multitude of reasons. GIS technology is now found in nearly all federal and state government agencies, educational institutions and large private firms, and is rapidly being adopted by local governments, environmental organizations, neighborhood organizations, and small firms. Increasingly, spatial data and analytical methods are being shared among these organizations. Simply being able to evaluate and extrapolate the contribution of digital spatial technologies to the national economy will contribute to our understanding of the working and transformation of that economy. Understanding rates of adoption, potential barriers to spread and the inter-relationship between the technology and different segments of society will contribute to the ability to increase the benefits of and equity of access to spatial information.

The technology has metamorphosed beyond a simple mapping tool to a methodology that is used for urban planning, environmental monitoring and analysis, marketing, transportation, management, and analyzing complex spatial problems. Access to geographic information over the world wide web, and new modes of distributed computing have significant societal implications. Recent announcement of initiatives to explore the implications of “Digital Earth” and “Digital Government” exemplify the variety of scales and applications. GIS is fully expected to contribute to education and to the reorganization of federal, state and local government. While there are many ways in which human activities can be carried out more effectively and democratically through the application of GIS, it is equally clear that the introduction of GIS can lead to unintended

consequences. There are particular dimensions associated with the visual power and locational precision of GIS which may result in intrusion into private lives. Inequity of access or benefits may reinforce existing social and spatial inequalities. The study of GIS and society is essential to maximize benefits across all segments of society, to identify and limit the undesirable consequences, and to direct the development of new geographic information technologies that are relevant and useful to all members of society.

The paper now visits each of the four themes identified in the background review and suggests a selection of related questions

Some basic economic questions should be answered regarding the overall cost of societal investment in order to assess benefits to society at large as well as by sector, and to evaluate the economic effectiveness of GIS at the institutional, sectional and national levels. From a baseline of the magnitude and distribution of expenditure on GIS it becomes possible in turn to evaluate rates of expenditure on GIS infrastructure and to describe rates of adoption by institutions, and by types of usage. The GIS industry extends far beyond hardware, software and data sales. In addition to data capture, conversion and maintenance; staffing and training costs it also includes support industries such as GPS.

**1. The following types of questions are important with respect to the status of GIS in society:**

- What is the dollar amount of investment made in GIS/LIS technology (hardware, software, data, and people (salaries and training)), in some other all-inclusive time period, aimed at determining the total investment made.
- Determine the annual dollar investment made in GIS/LIS to establish the rate of investment for any geographic area (i.e., neighborhood, city, county, region, state, etc.) including investment for the following sectors: local government, state government, federal government, and the private sector.
- What is the value of an individual GIS or collective set of systems in a community, state, or nation?
- What is the value placed on spatial data by the user? (e.g., Epstein and Duchesneau 1990; Dickinson and Calkins 1988; Dickinson 1989; Steger 1991; Moyer and Niemann 1991; Poe, Bishop, and Cochrane 1992) What is the rate of adoption of geographic information technologies locally, statewide, nationally and globally?
- What are the factors affecting the levels or rates of investment in GIS/LIS technology in the private sector and at the local, state, and federal government levels? (Obermeyer 1990; Moyer 1990; Cullis 1995)

Societal adoption of a technology and its diffusion in time and space is affected by various forces and factors. Adoption theory, historically, has been studied in depth across

many disciplines (Rogers 1995; Brown 1981). A number of scholars within the GIS community have also devoted research into the topic (Anderson 1996; Azad 1993; Budic 1994; Onsrud 1995; Onsrud and Pinto 1993). Additional research is needed to continue the validation process of the various adoption models that have been proposed or documented (Tulloch et al., 1997). Long-term monitoring of adoption rates requires longitudinal research methods. Assessing types and extent of overall use also requires longitudinal methods. These long-term methodologies are essential for providing a sound basis from which to assess and extrapolate societal impacts.

- What are the factors and forces that accelerate and/or inhibit the adoption of geospatial technology?
- To what degree can these factors be manipulated to control the rate of system adoption?
- Is there a relationship between the rate of system adoption, factors influencing adoption and the quality of system development?
- Are there policy, investment, or technical steps that can or should be taken to improve the adoption and system development process?

**2 With respect to the reciprocal relationship between GIS and society, the types of questions fall into two main groups:**

a) Questions about the capabilities and limitations of prevalent GIS software, and how these capabilities have evolved:

- What can and cannot be done easily with current software, and who is most comfortable using it?
- Who has access to spatial data, and how does accessibility affect the influence of users over social processes?
- How can various non-Euclidean geometries, complex and ambiguous spatial concepts and representations of social and physical space be embedded within a GIS? Is the currently dominant GIS software more appropriate for some cultures and social groups than others?
- How can the dominance of certain types of GIS be explained on efficiency grounds? by societal priorities? by historical contingencies? by the needs of large public and private institutions? by the ways in which complex networks of GIS developers and users have created a standardized set of ideas about what makes GIS important to society?
- What alternative GISs are possible, and who would be best served by their development?

b) Questions about the implications of these capabilities for different social groups and society in general:

- How is GIS affecting the relationships among and between different types of users and non-users, the ability of individuals to achieve their goals, and the relative influence of different groups over society?
- In which ways is GIS empowering social groups and individuals, making them aware of their rights (for example, to land) and increasing their participation in and influence over democratic processes?
- In which ways is GIS marginalizing social groups and individuals, by preventing equal access to information, by establishing or normalizing values, by downplaying particular views of the world, by creating unequal capacities for surveillance, and by creating inequalities in access to appropriate and effective tools for geographical analysis?
- How does the use of GIS affect users social practices and their views of society and nature?
- How is the use of GIS changing the geographical organization and the ecological and social sustainability of human societies, in different parts of the world?
- How are geographic information and geographic information technologies altering the nature of space and place as social constructs?

### **3 With respect to broadening the scope of the users of GIS**

A core set of questions needs to be asked about each of the different groups of potential user organizations identified above (government agencies, research and educational institutions, private corporations and firms, community and grassroots social organizations, and individuals). Representative types of question are:

- Who is and who is not adopting GIS, and what are they doing with it?
- How is the adoption of GIS affecting the tasks an organization undertakes, its ways of thinking and learning about the environment within which it operates, the ways in which it goes about its tasks, and the effectiveness and efficiency with which these tasks are completed?
- How does the adoption of GIS affect the relative influence of different participants within an organization?
- What are the implications of inequalities in GIS adoption within a group for the overall organizational structure of each of these groups of institutions (e.g., is it reinforcing the concentration of economic power within the private sector, the power of local government in the public sector, or the educational outcomes of schools)?
- How do the networks of users that develop (both within but also across the different groups) affect the views and norms held about the use and utility of GIS, and influence the direction of development of GIS technologies and databases?
- Beyond the group of organizations affected by its use of GIS, who else is affected by this use, and which of them benefit from or bear the costs of it?



- What are the social and economic factors that accelerate or inhibit access and use of GIS technology to enhance or protect their specific needs and values? (Harris and Weiner 1998)
- What are the concepts, technical factors and representations which accelerate or inhibit the adoption of GIS technology? (Onsrud and Pinto 1993; Tulloch et al., 1997; Cullis 1995)

**4 With respect to ethical and legal implications, the following questions are important:**

Information systems develop in a legal and institutional context including legislatures, government agencies, judiciary, proprietary and commercial, professional standards and practice and behavior as customary law. The processes encompassed by the elements define the rights and interests people have in data, technology and expertise. Distinct questions are raised by spatial data and technology including individual rights to examine or acquire publicly held data, the transition of public spatial data and technological investment into a privatized environment

- Interaction at the individual level underpins all other human relationships. What, if any, are the interpersonal implications of GIS?
- In which ways does GIS enhance surveillance capabilities, and which regulatory mechanisms are necessary or possible to limit surveillance?
- What additional intrusions into privacy result from the capacity to map geographic information, and what cartographic techniques can be used to maintain confidentiality of individuals?
- What are the ethical implications of geographic information technologies? Should software design and GIS use be governed by ethical considerations? How might these be implemented?
- How accessible will spatial data and related GIS analysis tools be to all aspects of society. (Curry 1994; Onsrud and Rushton 1995)
- What is the status of legal regimes that determine who and under what conditions has access to public data, considering both the letter of the law and actual practice?
- How does the commercial use of public information by private groups and individuals influence access to public data?
- Can GIS provide citizens with an increased ability to monitor and hold government accountable for proposals and actions?
- Will GIS provide citizens with a better understanding of their rights and interests in land or other resources?
- What is the impact on other parts of the world of the diffusion of GIS and associated regulatory and legal norms developed elsewhere?

Based on these general goals and projects, examples of more detailed projects may be used to articulate the importance of basic research about the relationship between GIS and society.

## 1. Case study research

Since the evolving relationships between society and GIS can take many directions depending on their context, and given that we know less about actual consequences than we do about potential consequences, initial progress is best pursued through a series of carefully selected case studies of particular organizational and geographic contexts. Since less is known about GIS in the private sector and in community organizations, case studies of these contexts will be particularly useful to both further develop and also challenge and improve our understanding of theoretical scenarios. Possible cases could address:

The use of geodemographic marketing by firms: Its effect on the success of those firms, and its effect on the attitudes, purchasing behavior and social make-up of the neighborhoods and social groups targeted by such GIS software.

The use of GIS software by neighborhood organizations in low income and minority communities, seeking to improve the social and physical environment available to community residents: Its effect on the ability of these organizations to make or negotiate improvements; and its effect on the internal coherence of these organizations and their ability to represent the diversity of views of local residents.

The ways in which norms about where and how GIS should be used, about how GIS is thought and talked about, and about the putative benefits of GIS, result from the practices of GIS and the networks of GIS users and GIS organizations.

The influence of GIS on the actions of government agencies, and on the capacity of the general public to assert democratic influence over those agencies.

Studies of controversial applications of GIS, paying attention to what can be learned about appropriate ethical principles and legal regulatory mechanisms.

## 2. Comparative analysis of case study results.

In concert with and drawing on such individual case studies, comparative analysis across case studies will be important to tease out which kinds of contextual conditions affect which kinds of outcomes. This will be as important for the study of how social practices influence the evolution of GIS technologies as it is for the study of the social implications of GIS. Such analysis should compare both case studies of similar organizational contexts in different places, and case studies of different organizational contexts in similar places.

A successful outcome of such comparisons would be the development of mid-range generalizations about the relationships between GIS and society, and about ethical and legal principles, which may be capable of further examination through a combination of extensive empirical analyses and new targeted case studies. Progress on these questions will depend crucially on fostering collaborative research networks.

### 3. Alternative GISs.

It is important to develop a parallel area of research into new types of GIS technologies, perhaps more reflective of the flexibility and communicative logic of Java and the Web than the complex logic of expert programs over which users have little influence. To be effective in designing geographical information systems that are appropriate for all areas of society, such developments should combine the practical experiences of new users struggling with currently dominant GISs; the expertise of programmers, graphic artists and communications specialists; and that of individuals skilled in the study of GIS and society. Focused research in this area will increase the possibility of lateral development of new approaches to GIS which can qualitatively enhance their relevance for an equitable and democratic society.

#### Priority Areas for Research

The breadth of research suggested by the questions in the previous section provides no excuse for lack of depth and rigor of inquiry into GIS and society. The interdisciplinary, multi-faceted approach required for inquiry into such diverse subject matter has been stressed, recognizing the inevitability of different, sometimes competing, theoretical and methodological approaches. We call for a careful focus on the significance difference engendered by geographic and spatial aspects of information technology and society, placing some questions firmly in the mainstream of current concerns for assessment of economic effectiveness and efficiency. At the same time the role of GIS in the reinvention, restructuring, and renovation government, business, and education, provides numerous opportunities for evaluation of other measures other than financial impacts. In summary the following areas represent the principal issues facing the community of scholars interested in GIS and society research.

#### Assessment of some basic contextual questions:

- Assessment, evaluation and interpretation of the status and trends of GIS adoption and utilization,
- Assessment, evaluation and interpretation of the status, nature, magnitude and trends of mutual influences between GIS and society,
- Access to spatial data, analytical power and information, including inequity, differential, economic cultural influences of pricing and quality.

Development of different practices and a range of GIS technologies:  
Influences of society on GIS technology and practice,  
Alternative GIS and GIS practice among low income, minority and indigenous peoples,  
Educational implications and implications of GIS education.

Ethical and moral implications, especially those relating to individual privacy:  
Effects on social organizations, groups and places affected by uses and outcomes of GIS,  
Problems engendered by domination over spatial data, information systems through business monopolies or political hegemony.

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