GIS AND SOCIETY

VIEWPOINT

A Research Agenda

GIS and Society

A working paper

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...This is an historic initiative. Such an investment will create tremendous results in the scientific community and in the economy…As information technology goes, so will our jobs, our incomes, and the success of our nation.

Al Gore, January 24, 1999, speaking about the Clinton/Gore $366 million information technology proposal: *Information Technology for the 21st Century*

Geographic information systems (GIS)—once an obscure technology used by a few far-sighted geographers, surveyors and planners—have become THE spatial information technology of the 1990s. In retrospect, this is not surprising—the technology has spawned many products and innovations that are now widely used in the management of land and its resources. Applications have proliferated through all levels of government; GIS is now commonplace in major sectors of service, marketing, utility, and transportation industries.

The federal government is spending billions of dollars to build a "spatial data infrastructure" (FGDC/NSGIC 1998) and to subsidize related technologies such as global positioning systems (GPS). Billions are spent by state and local governments to manage land records, administer programs and services, and to plan and manage uses of land and resources. And both corporate and non-profit corporations are spending billions more on a broad array of applications.

How many billions? No one knows for sure. And more importantly, what are the benefits of this investment, particularly the public dollars going into GIS? Again, we don't know. The evidence we have is largely anecdotal and limited in scope. Given the magnitude of society's investment, we need to understand the nature and scope of GIS use, and its positive and negative impacts. These objectives range from better accounting of GIS-fostered efficiencies, to validating claims of more effective decision-making, to understanding issues of equity, access, privacy and control.

Some Basic Questions

Although the science behind GIS is understood and widely used, as with most innovations, the broader societal effects of the technology are less well understood. How will this technology influence—and be influenced by—the political, economic, legal, and institutional structures of society? What factors will influence GIS adoption, development and use? Many people view access to information and to information technology as fundamental for improving lifestyle choices for most Americans (Gingrich 1995, p. 60). Conversely, many also see potential problems in such issues as lack of access and reductions in privacy (Lopez 1994; Onsrud, Johnson, and Lopez 1994; Naisbitt 1998).

Research needs to address some basic questions: What is the status of GIS today? How much is being spent? Who benefits? Where is the technology headed? How is it influencing society at large? How is society, in turn, molding its evolution?

A Research Agenda

According to Tulloch *et al.* (1997), we need information about—and insight into—two fundamental socio-economic aspects of GIS:

1) Status

- The magnitude and rate of GIS expenditures across all sectors of society
- The rate of GIS adoption, use and participation across all sectors of society
- The status of access, property and privacy rights in data, technology and expertise

2) Influences

- The influence of systems on society
- The influence of society on systems

Research on the **magnitude and rate of investment** in GIS will provide a basis for monitoring and evaluating the economic contribution of the GIS industry to the overall GNP (gross national product), and to the ITGNP (information technology gross national product). It will help us track public expenditures in terms of capital and human investment. This research will form the economic basis for evaluating the impact of GIS upon society and its institutions.

Research on the **rate of GIS adoption and use** will provide a basis for studying and evaluating the technical, economic, social, legal and political factors that accelerate or inhibit adoption. It will provide information about how GISs are used, and the characteristics and sophistication of various users. This research will help us determine the rate and types of uses, thereby revealing the overall effectiveness of such investments. It will help determine which segments of society are able (or not able) to adapt GIS to their purposes and why (incentives and barriers).

Research on the **status of rights in data, technology and expertise** will provide a framework to examine the status of the public right to access and use publicly held data, technology and expertise. It will address how to gain access to and expedite the use of the necessary expertise to fully deploy the technology and utilize the data. Research will help the GIS community determine intellectual property rights in information, and develop the means to protect individual privacy.

Research on the **influence of systems on society** will provide a measure of the benefits from investments and use. It will provide a means for examining the impacts of information on decision-making related to land and resource issues, as well as the impact of data and information on the changing relationships among citizens, public agencies, private and non-governmental entities. This research will help clarify and document the overall societal impact of the investments in geospatial technology. It will also help document the extent (if any) of empowerment and equity which users have derived from investments in geospatial technology.

Research on the **influence of society on system development** will document the impact of society on system development; that is, how a society influences the acquisition of data and those who provide it, and how these systems incorporate the perspectives of all members of society—including low-income, minority, and indigenous people. In addition, this research will document how societal demands have influenced the development of geospatial information technologies; in particular, how GIS software responds to societal requirements.

The Role of UCGIS

Research on GIS and society requires a cross-disciplinary approach. Involvement of the social sciences such as economics, law, political science, sociology and psychology in addition to mainstream GIS disciplines like geography, planning, geodesy, computer science and other user-driven disciplines is essential. The likely players are 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, and economic purposes—especially in resolving land-related disputes. This is the symbiotic working relationship needed to fully understand the social ramifications of GIS.

The University Consortium for Geographic Information Science (UCGIS) should be instrumental in bringing the geospatial community together and in establishing a research agenda. UCGIS must stimulate interest and involvement in "GIS and Society" research, especially in those disciplines beyond mainstream GIS. Without a firm understanding of the consequences of GIS use, much effort may be wasted or lost. Technology and good intentions, without vision and wise use, could ultimately result in few benefits while generating misunderstanding and opposition.

National Research Takes GIS to Next Level

Basic research into the rate of investment in and adoption of GIS, the effects of GIS on society, and the relationship among these effects is significant to a national research agenda for several reasons. GIS technology is now found in nearly all federal and state government agencies and is increasingly used by local governments, environmental organizations, and even neighborhood organizations and individuals. Also, various private sector organizations are employing GIS technology for a variety of locational and marketing applications. Increasingly, spatial data are being shared among these organizations. The technology is not simply a mapping tool. It now incorporates methodologies for environmental analysis. It provides the means for understanding complex spatial problems. It is used for a variety of scales and places. (Vice-President Gore has recently called for a worldwide digital system called "Digital Earth.") Most importantly, the technology is increasingly being used for human/natural resource policy formulation. Now is the time, on the eve of a new millenium, to gain a clearer understanding of the links between society, GIS technology and science.

Part I of this paper will propose a research framework for examining "where we are"—the status of GIS development. Part II will focus on research designed to help us define and describe "where we're going." Each will highlight important areas of research and suggest specific goals and projects. Keep in mind that this research proposal framework is a work in progress—ideas likely will evolve and be refined over time.

PART I

STATUS OF GEOSPATIAL INFORMATION SYSTEM DEVELOPMENT

Magnitude and Rate of Expenditures

Simply stated, if we are going to assess benefits and evaluate impacts, we must have some method for measuring the total value of societal investment. This method will involve basic data that reflect what is actually spent and for what purposes by a representative sample of public and private organizations nationwide. The data are there; now we need to establish and apply a satisfactory method for identifying and measuring these investments. We need to establish a baseline from which we can assess societal benefits and impacts. This baseline will become the basis for understanding the rate and magnitude of future economic investment in these systems.

To date, investment data reported by private-market assessment firms that monitor GIS investments, usually by company, comprise much of what we know about the cumulative economic impact of the GIS industry. However, the industry extends well beyond software and hardware sales. In addition to data conversion and maintenance, training, and staffing costs, it also includes support industries such as GPS (global positioning systems). A potential new source of investment data may be the National Framework Data Survey (FGDC/NSGIC 1998). For each of several types of data, the questionnaire asks respondents to "estimate the amount your organization spends annually on creating, updating, integrating, and/or distributing" theme data. Survey results are forthcoming. However, it is not clear that this method provides the data needed to represent a variety of venues.

Also, the variety and extent of public sources of investment are not well documented and understood. In Wisconsin, for example, the actual expenditures generated and invested within the statutorily mandated Wisconsin Land Information Program (WLIP) are easily documented. In fact, data on the full breadth of local investment are lacking. It appears that for each dollar of WLIP investment, another dollar is voluntarily matched from a variety of non-program revenue sources (Tulloch and Niemann 1997). In essence, this doubles the rate of annual investment. This would result in an overall investment, in Wisconsin alone, of $100 million by the end of the decade.

Proposed Research

- What is the dollar amount of investment made in GIS/LIS (land information system) technology (hardware, software, data, salaries and training), in the last ten—or other number—years? The aim is to establish a baseline.
- What is the dollar investment made in GIS/LIS technology in the last 12 months? The aim is to assess rate of investment.

[Both of these questions can be addressed within a specific geographic area (i.e., city, county, region, state, etc.) and should include investment for the following sectors: local government (township, village, city, and county), state government, federal government, and the private sector (utilities and others).]

(continued from page 4)

- What is the value of the individual geospatial data system, or collective set of systems, in a community, state, or nation? What is the value of data as measured by the efficiency of their use rather than by the magnitude of investment in their production? (e.g., Epstein and Duchesneau 1984, 1990; Dickinson and Calkins 1988; Dickinson 1989; Onsrud 1989; Steger 1991; Moyer and Niemann 1991; Poe, Bishop, and Cochrane 1992) The answer to this question is difficult because it requires a sophisticated representation of how data are actually used.

- What are the factors affecting the level (or rate) of investment in GIS/LIS technology at the local, state, and federal government levels? (Obermeyer 1990; Moyer 1990; Onsrud and Pinto 1993; Cullis 1995a, 1995b; Tulloch 1997) Examples include:

  √ Unemployment rate
  √ Rate of population growth
  √ Rate of new parcel creation (summation of splits and combinations, aimed at measuring economic growth as evidenced by land related development)
  √ Number (or rate) of permits for new building construction (or zoning changes, or utility hookups, etc.)
  √ Rate and/or magnitude of increase in property tax base
  √ Rate and/or magnitude of increase in income tax collections
  √ Investment (or sales) in GIS/LIS software
  √ Investment (or sales) in GIS/LIS (dedicated) hardware
  √ Direct and indirect mandates requiring GIS competition with peer jurisdictions

- What is the rate, and types, of GIS investment? What is the nature of the forces and factors in developing Multi-Purpose Land Information Systems (MPLIS)? (Tulloch 1997)

The Rate of Adoption and Type of Use

The rate of monetary investment in data, hardware, software and procedures is not the same as the rate of adoption and use. Spatial and sectoral patterns of adoption provide an indication of who benefits and when.

Societal adoption of a technology is affected by various forces and factors. Theory about the adoption of innovations has arisen from many disciplines (Portner and Niemann 1982, 1983; Rogers 1995; Brown 1981). A number of scholars within the GIS community have also devoted research into the topic (Budic 1993a, 1993b, 1994; Onsrud 1995; Onsrud and Pinto 1993; Azad 1993; Anderson 1996). This conceptual work has proven useful for various groups and agencies and has led to tools for observation. For example, the Federal Geographic Data Committee (FGDC) recently performed a nationwide survey in order to create a snapshot of the status of digital geographic data in the United States. The Wisconsin Land Information Board has relied on survey research to monitor longitudinally the rate of investment and adoption of GIS technology and database development across all of the state's local governments. While these efforts have contributed to the larger body of knowledge, they have been limited in scope and/or nature, leaving much unknown.

Proposed Research

- What is the nature and rate of adoption of geospatial technologies locally, statewide, nationally and globally?
- 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 development?
- Is there a relationship between the rate of system development, factors influencing development and the quality of system development?
- Are there policy, investment, or technical steps that can/should be taken to improve the system development process?

We need additional research to continue the process of separating the concept of investment from that of using and developing the various adoption models that have been proposed or documented (Tulloch 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.

Rights Pertaining to Data, Technology and Expertise

A Basic Right?

Information systems develop in a legal and institutional context. This context includes the influences of legislatures, agencies, courts, professional standards and practices, and customary behavior (customary law). The legal process encompassed by these elements defines the rights and interests that people have in data, technology, and expertise.

Several areas are of particular interest to GIS development. One is the legal regime that determines individual rights to acquire or examine publicly held data. This regime focuses on public, private, and economic factors that, together, define rights such as access to, and cost of, public information. The economic aspect includes questions about sustaining public systems and the appropriateness of public funding for GIS elements followed by large, private commercial gain after low-cost access (e.g., GPS and its use).

Controversy is attached to the questions of rights and access to public information. These topics have been considered with an individual attention to access, privacy, and economics. However, the way that recent technological development influences the interaction among these issues has not been fully examined. Historical concepts and the role of customary law have not been studied in the context of their influence on these rights.

Questions that arise here include:

Who has access to data and information? (Onsrud and Rushton 1995; Epstein 1993)
Under what conditions?
What shall be withheld?
How does the need to build and sustain expensive systems influence rights? (Onsrud, Johnson, Winnecki 1996)
What is the influence on rights of a need to build and sustain expensive systems? (Onsrud, Johnson, Winnecki 1996)
What is the influence of commercial use of public information and gain by private groups and individuals on rights? (Onsrud and Rushton 1995)
What principles appropriately resolve these questions?

Proposed Research

- What is the status of legal regimes that determine who has access to public data and under what conditions, considering both the letter of the law and actual practice?
- What is the status of exceptions to access limits?
- How does commercial use of public information by private groups and individuals influence access to public data?
- What are the interpersonal implications of GIS? Interaction at the individual level underpins all other relation ships?
- Can GISs provide citizens with an increased ability to monitor and hold government accountable for proposals and actions?
- Will GISs provide citizens with a better understanding of their rights and interests in land?
- How accessible will spatial data and related GIS analysis tools be to all aspects of society? (Onsrud and Rushton 1995)
- Can we ensure that all parts of society will have access to spatial information? (Curry 1994)
- What implications does research on the relationship between GISs and society reveal with regard to the types of ethical and legal restrictions that should be placed on access to and use of GISs?
- What factors promote or inhibit data sharing among various government and other agencies? (Onsrud and Rushton 1995; Pinto and Onsrud 1995)

Questions of copyright

A second, related area of interest is that of formal property rights in the data and information or in the technology (software and hardware). Copyright law may apply here. This often determines the nature of subsequent use of data, if available.

Questions that arise here include:

To what aspects of data and their representation as maps does copyright apply? (Roitman 1990)

Does copyright apply to all data and information assembled by a government agency in order to execute its mandated functions?

Can a government agency refuse a freedom of information request for data and information that it uses when that material has been obtained for a private source that has copyrighted the material? (Epstein 1993)

Should copyright apply to software?

Proposed Research

- How does copyright law apply to data, information, and knowledge?
- How does copyright law apply to data and information created by a government in order to execute its mandated functions?
- What is the relation between freedom of information, copyright, and contract law in regard to material assembled by a government from a private source that holds a copyright in the material?

Who is Responsible?

A third issue is that of who has responsibility (liability) for data and information used to make decisions or take actions when the trail from observation of locations to use of an information product is so fragmented and specialized. It is not uncommon for a technician with little expertise—except for how to operate a GIS software system—to generate a map for a decision-maker who has little knowledge of data quality. The question here: who is responsible when something goes wrong?

People have expectations in regard to the quality of the data they obtain from others and then use. The state of that expectation factors greatly in the issue of liability of data providers for the data they distribute.

Questions that arise here include:

What is the exposure of public and private data, hardware, software and expertise providers to liability for the nature and extent of their products and services?

What are the expectations in regard to product and service quality? By whom? From whom?

What actions are appropriate by providers and users to protect against liability?

Proposed Research

- What laws apply to the issue of liability for information products and services?
- Do traditional principles for resolution of liability issues apply to the modern technological world?
- What problems are foreseeable and how can these be handled?

PART II

SYSTEMS AND SOCIETY: MUTUAL INFLUENCES

How GIS Influences Society

Benefits

The considerable investment, both public and private, in spatial information technologies is accompanied by various levels of uncertainty surrounding the extent, value and impact of this investment and the rate and extent of actual GIS adoption. The value of this investment needs to be justified in terms of benefits to society, and ample opportunity exists to more carefully investigate these benefits (Goodchild 1995, p. 41). Our current discussion of benefits and impacts is primarily in the realm of measuring the cost of generating and using data and information; however some ideas are emerging that concern efficiency—reducing costs for implementers via improved means to produce information. In combination with a more thorough understanding of these costs, we must develop measures of benefits that incorporate an understanding of the role of the technology and the information it provides in decision-making about people, land and resources. These benefits are not about reductions in the costs of generating and using data and information, but about the impact of data and information use on people's lives. Assessment of technological impacts must include issues of equity, including the distribution of costs and benefits among individuals and between components of society.

Previous research in this area has been directed toward efficiency measures of implementation processes. For example, we have measured the status of implementation on a statewide basis and assessed the impact of GIS and land information systems (GIS/LIS) in terms of efficiencies that the technologies bring to traditional activities of data and information management. However, societal implications cannot be fully understood without studying the impact of these systems on expectations arising from the broader economic, legal, political, and cultural context. We need to adopt and develop theories—as well as measurement tools and techniques—for determining how spatial information influences land and policy decisions. These techniques should incorporate concepts of the effectiveness and equity of decisions.

The products of spatial information technologies are changing (and will continue to change) the economic, legal, political, and cultural status of adopting agencies, decision-makers using the products, and the people and organizations affected by the decisions. While early impacts of GIS/LIS are becoming evident, little is known or understood about the long-term effects that the products of these technologies will have on the communities and organizations that implement them. We should observe, and ultimately be able to predict, how spatial information technology and products alter decision-making processes within organizations, and how they affect interactions between agencies, citizens'relationships with government agencies, and people's beliefs and actions in regard to the use and management of land and resources (Zwart 1988, 1994). One can point to the examples of the importance of GIS's current and potential application in epidemiological studies, and in the increasing use of GIS in restructuring political districts—each with tremendous potential impact on issues of societal concern. A major challenge is how to define and measure these impacts in quantitative as well as qualitative ways.

The role of information in decision-making

Decisions imply the existence of uncertainty and choice among alternatives. Rationally, the decision-maker seeks additional information in order to minimize uncertainty. However, cost limits the extent of uncertainty reduction by means of data and information gathering (Moyer 1993). Another important limitation is the general role of information in decision-making. Students of dispute resolution understand that factors such as values, positions, attitudes towards opponents, and potential outcomes influence decision-making in ways that may even preclude the use of information. The social aspects are gathered under the title: "Framing theory."

Land management is the art and science of making decisions in support of perceived objectives with respect to the inventory, allocation, and development of land and its resources. A basic component in land and resource management is land and geographic information, gathered in an informal, intuitive fashion but increasingly in a formal, systematic process—the product of an information system. The extent to which the products of that system are used in land management in contrast to the use of human, social perceptions, is not fully developed. Application of framing theory in resource and environmental dispute resolution affords an opportunity to explore the possibilities and limits of the use of information system products in land management. Wetlands management, soil and water conservation, subdivision development, and many other examples of controversial decision-making can be explored (Crain and MacDonald 1983). Specific techniques, such as multi-criteria analysis (Fumiko and Sakawa 1988; Nijkamp, Rietveld, and Voogd 1990; Nieman, Meshenko, and Tackett 1984) can also be applied in new ways to aid decision-making processes.

Proposed Research

1. Efficiency

- What is the cost efficiency of GIS technology for various local governments in comparison with other nonspatial approaches? (Moyer 1975, 1977)
- What sort of benefits can society expect from these systems? (Moyer 1990, 1993)

2. Effectiveness

- How can GISs assist in assessing environmental justice issues, including the relationship between Toxic Release Inventory sites, toxic dumps, Superfund sites, and human populations?
- 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? In what ways do alternative forms of representation remain to be explored and incorporated? (Sheppard 1995)
- What sort of benefits are communities receiving from (or through) the application of these systems? (Craig 1994; Craig and Johnson 1997)
- What types of disputes might use spatial information for their resolution?
- When are spatial data useful in the dispute resolution process?

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3. Equity

- How will GISs affect the relationships among and within government agencies, non-governmental groups, and citizens? (Curry 1997)
- Can GISs be used to increase participation in public decision-making? (Lang 1995; Schroeder 1997)
- What is the potential for a GIS that combines conventional socio-economic, environmental, and infrastructure data with non-conventional behavioral and cognitive information? (Poiker and Sheppard 1995) For instance, how can the geography of Los Angeles gangs be represented in a GIS?
- How can spatial data be used by environmental and community groups for empowerment and for conflict resolution? (Sieber 1997)
- 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? (Harris *et al*. 1995; Weiner *et al*. 1995)
- What possibilities and limitations are associated with using GISs as participatory tools for democratic resolution of social and environmental conflicts? (Schroeder 1997)
- Who controls the admission and use of spatial data for dispute resolution?

The use of data by private and non-governmental organizations

Adoption of GIS technology by the private sector for a variety of applications has been extensive during the past decade. According to various market reports, large amounts of money and human effort have been expended to develop this technology (Crockett 1997). The impacts on the companies that have invested in GIS technology have been significant. GIS has changed how problems are conceptualized, how resources are allocated, the geographical configuration of the supporting infrastructure and facilities, and marketing evaluation and strategies. It is likely that these private sector impacts could well exceed those in the academic, public and non-governmental sectors. For whatever reasons, the research community has clearly been negligent in regards to understanding the extent of private sector contributions and impacts on the overall GIS industry.

Proposed Research

- What is the rate of GIS adoption in the private sector?
- What is the resulting influence of this adoption on a company's market size and competitiveness?
- Have changes occurred in the research, development and marketing in the private sector due to GIS utilization?
- What are the economic and social impacts of more effective evaluation of market potential and better targeted advertising provided by GIS?
- What has been the impact of GIS-software market concentration on the reliability and validity of the outcomes produced by these software products?

How Society Influences GIS Development

Impact of Society

Users of geospatial technology impact the systems via various forums and methods. The most obvious method is through the power of the pocketbook: what is purchased and maintained and what withers and vanishes through lack of investment (known as the demand side). For example, initial technical complexity evolves toward user-friendliness and ubiquitous use, demand is expanded and the end-user becomes more influential (Zwart 1991, 1993). Public forums such as annual user and professional meetings, and research reported in journals and at professional meetings, also impact the demand for systems development. Mechanical methods include benchmarks and related specifications. New and creative influences are less predictable but can have major impacts on development and implementation. Emergence of new related technologies, other disciplines, and traditions enter into the intellectual mix. As the critical mass of these new frontiers expands, new insights and solutions emerge, driving the nature and form of systems and software.

Examples include the seemingly long evolution from computer-aided drafting (CAD) to topologically based GIS. Also, similar movement toward more sophisticated and easier-to-use database structures such as object-oriented architectures evolved. Beyond the technology itself, there have been seemingly long delays in adoption and diffusion of GIS in, for example, the business sector. In contrast, there has been a dramatic uptake and demand for other geospatial technologies, such as access to inexpensive coordinates through the use of global positioning systems (GPS). As a result, new industries have been created—ones that cut across diverse audiences and applications that include precise geodetic surveying, parcel mapping, vehicle navigation, real-time nautical navigation, mobile on-the-fly dynamic boundary and path mapping, and use by hunters, birders, and other recreational users.

Society has other, non-technical means by which it impacts the rate of development and use of any technology. Lawmakers can impose trade restrictions or sanctions, such as for defense or other purposes. They can impose fee or cost-recovery structures that can restrict the flow of access and use of data or restrict access by limiting public availability. And they can provide funding for research and development of particular tools and technologies. This is clearly the case for GIS where major advances have been made in public agencies or by research with public funds.

Society influences the rate of development and use of a technology such as GIS and its products in the “land-use drama” where specific decisions about land use are made (Ellickson and Tarlock, 1981). The decision-making context is the statute-based, administrative process where, for example, subdivision, zoning, variance, flood hazard, wetland, energy facility, transportation, and other permit applications are heard.

Statutes and administrative regulations determine the procedures, notice, participants, decision criteria and review standards for the land management process. Data and information are presented or excluded in an often contentious setting. The formal (legally defined) and informal (common practice) procedures determine what data and information is acceptable and used to make the decision. This context can be intimidating to some or a means of exercising power by others. In some cases, the context is seen by some as unfair, with the result that these people are not willing to participate.

These practices determine the conditions under which data and information are receivable and actually used to make land and resource allocation decisions. Those who have the political and financial power to allocate resources to agencies for GIS/LIS development are generally aware of the nature of the land drama, its requirements and how to use it. Their knowledge and power significantly influences the GIS/LIS systems that will be supported. This suggests that those concerned with GIS/LIS in society closely consider the social and legal aspects of the land management administrative process if they want to improve the equity of the information systems.

Proposed Research

- What is the impact of demand (or lack thereof) on the development of specific geospatial tools and systems?
- What impact do access fees have upon existing and potential users?
- In what ways will GIS actually affect and/or alter the society it is intended to represent and analyze?
- How do public-information policy and technology-transfer activities influence system design and adoption?
- How do public-information policy and technology-transfer activities influence software development and marketing?
- How are land use disputes framed and resolved?
- How are spatial data and information actually used to resolve land-use disputes?
- What are the attitudes of participants and potential participants in the land-use drama towards the use of spatial data and information?

Acquisition of data, information, and perspectives by public agencies

An aspect of GIS development that constrains the impact of society on systems are the institutional, professional, and customary practices that limit the ability of agencies, and ultimately the public, to fully extract and correlate the data, information, and perspectives embedded in the spatial material they receive in the normal course of their authorized activity. Subdivision plats, development plans, and environmental impact statements are examples (there are many others) of material received or required by agencies. Often, there are no standards for the form of the material even when it is required for a land use or other permit. Or, the receiving agency lacks the ability or resources to integrate the material with the form of existing data that apply to the same area. The submitted material often contains representations of the applicant's sense of the land or how the applicant wants the land to be perceived. These documents become a part of the public record and modify property rights. However, they remain independent and segregated from other data making a full understanding of the land tenure difficult or impossible.

Agency independence, lack of broadly applicable, practical standards for the form of submitted data, and lack of resources and technical training in agencies are part of the problem. However, other factors include the politics of expertise where some parties seek to retain the ability to influence decision-making by retaining the optimum freedom to determine the nature and extent of data use to make decisions. The result is a disorder in data that limits the free flow of people's perceptions of land into the files of public data. This problem is particularly difficult because the political power of individuals and agencies is an issue. At its heart is the problem of whether system development will proceed from a local, land management unit perspective, or from a national hierarchical source.

Proposed Research

- Can GISs be developed to reflect complex and ambiguous perceptions of social and physical space?
- What are the form and content of spatial data and information received by government agencies in their permit, environmental assessment, and other land management activities?
- What actions are taken to integrate this material with existing data?
- What standards exist for applicants who submit data and information to administrative agencies?
- What other standards are reasonable?

Perspectives of low-income, minority, and indigenous people

Access to GIS technology and its data sets offers the potential to empower those of lesser means or different traditions; however, lack of access offers potential to further disenfranchise and separate societal participation of these groups. Alternatively, increased access to data technology and expertise may serve to empower these groups. Research is needed to more clearly document the status and extent of such access.

Some examples indicate growing access and capacity for indigenous societies such as American Indian nations in the United States. The Great Lakes Indian Fish and Wildlife Commission (GLIFWC), a group of midwestern Chippewa tribes, are constructing a comprehensive GIS database for their original ceded territory where they maintain traditional hunting, fishing and gathering rites/rights. The database consists of a variety of cultural and natural variables including tenure rights of trespass. Various Pueblo nations in the Southwest are building various capacities by helping and encouraging the Southwest Indian Polytechnic Institute (SIPI) to expand their technical curriculum and instruction in GIS and GPS. In Montana, the Salish-Kootenai tribe has established and operates their own technically advanced GIS. It includes the results of their efforts to search the many land records offices for documents that establish the precise nature and extent of their treaty lands and rights. While they are aggressive in their search of Anglo government records, they are quite careful and sophisticated about the release of data about the location and cultural attributes of sites and areas under their control. They choose when and how this material is released, if at all, based on their sense of how that release will help them. They do not need intermediaries to understand and interpret their social and political circumstances and to operate their GIS.

Proposed Research

- What are the social and economic factors that accelerate or inhibit access and use of GIS technology to enhance or protect specific needs and values of those who participate in or are affected b;y the results of the land use drama? (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 1997; Cullis 1995a; 1995b)
- How can various conceptions and representations of space. not based on traditional map (Euclidean) views, be embedded within a GIS? Is GIS more or less appropriate for some cultures versus others? Can GISs be developed to reflect complex and ambiguous perceptions of social and physical space? (Pickles 1995)

Where Now?

This paper, presented in part at the UCGIS conference in 1998, is designed as part of the general effort to examine what we sometimes refer to as "GIS and Society." While we have sought to work with generally accepted ideas, new discussions and ideas emerged at the 1998 conference and in the months that followed. Consequently, we have developed this paper as a statement of new, and often immediate, directions that we would like to see incorporated within the larger body of research.

One research category is particularly pressing: baseline evaluations of emerging systems. Currently, many of the developing geospatial systems and related processes are influenced by a broad awareness and knowledge of the range of available development options. Now is the time to capture the costs and inputs of these developing systems *before* they become driven solely by local, individual site- and time-specific conditions within a community. We hope that examples of this research will become a standard component of observations about adoption, use and impacts of GIS.

References

Anderson, C.S. 1996. "GIS Development Process: A Framework for Considering the Initiation, Acquisition, and Incorporation of GIS Technology," *URISA Journal*, 8, 1: 10-26.

Azad, B. 1993. "Theory and Measurement In GIS Implementation Research: Critique and Proposals," In: 3rd International Conference of Computers in Urban Planning and Management. July 23-25, Atlanta, GA.

Brown, L.A. 1981. *Innovation Diffusion: A New Perspective.* London: Methuen.

Budic, Z.D. 1993a. "GIS Use Among Southeastern Local Governments," *URISA Journal,* 5,1: 4-17.

Budic, Z.D. 1993b. Human and Institutional Factors in GIS Implementation by Local Governments. Ph.D. Dissertation, Dept. of City and Regional Planning, University of North Carolina at Chapel Hill, 1993.

Budic, Z.D. 1994. "Effectiveness of Geographic Information Systems in Local Government Planning," *Journal of the American Planning Association,* 60 (Spring): 244-263.

Chrisman, N.R. 1987. "Design of Geographic Information Systems Based on Social and Cultural Goals." *Photogrammetric Engineering and Remote Sensing* 53 (10): 1367-1370.

Craig, W.J. 1994. "The Rising Tide of GIS in Minnesota," *URISA Journal*, 6,1: 75-80.

Craig, W. and D. Johnson. 1997. "Maximizing GIS Benefits To Society," *Geo Info Systems*, 7 (Mar) 3:14-18.

Crain, I.K. and C.L. MacDonald. 1984. "From Land Inventory to Land Management," *Cartographica,* 21: 40-46.

Crockett, M, 1997. "GIS Companies Race for Market Share." *GIS World*, Vol. 10, No. 11, pp. 54-57.

Cullis, B.J. 1995a. "An Exploratory Analysis of Responses to Geographic Information System Adoption on Tri-Service Military Installations." Vicksburg, MS: U.S. Army Engineer Waterways Experiment Station.

Cullis, B. J. 1995b." Modeling Innovation Adoption Responses: An Exploratory Analysis of Geographic Information System Implementation at Defense Installations." Ph.D. Dissertation. Columbia, SC: University of South Carolina.

Curry, M. 1997. "The Digital Individual and the Private Realm." *Annals of the Association of American Geographers* 87 (4): 681-699.

Curry, Michael. 1994. "Image, Practice and the Hidden Impacts of Geographic Information Systems." *Progress in Human Geography* 18: 44, 441-459.

Dickinson, H.J. 1989. Selective bibliography: *Value of Information*. NCGIA Technical Paper, NCGIA, Santa Barbara, CA.

Dickinson, H.J., and H. Calkins. 1988. "The Economic Evaluation of Implementing a GIS," *International Journal of Geographic Information Systems* 4, 4: 307-327.

Epstein, E.F. 1993. "Control of Public Information," Chapter 17 in *Institutions Sharing Information*, Proceedings of the I9 Specialists Conference, NCGIA, San Diego, February 1992.

Epstein, E.F. and T.D. Duchesneau. 1984. The Use and Value of a Geodetic Reference System, Rockville, MD: National Geodetic Control Committee, US Department of Commerce.

Epstein, E.F. and T.D. Duchesneau. 1990. "Use and Value of a Geodetic Reference System," *URISA Journal*, 2, 1: 11-25.

Epstein, E.F., D.L. Tulloch, B.J. Niemann, S.J. Ventura, and F.W. Limp. 1996. "Comparative Study of Land Records Modernization in Multiple States," Proceedings, GIS/LIS '96.

Gingrich, N., 1995. *To Renew America*. New York: Harper Paperback.

Goodchild, M. ., 1995. "Geographic Information Systems and Geographic Research." In J. Pickles, editor, *Ground Truth: The Social Implications of Geographic Information Systems.* New York: The Guilford Press.

Harris, T. and D. Weiner. 1998. “Empowerment, Marginalization and ‘Community-integrated’GIS.” *Cartography and Geographic Information Systems* (forthcoming).

Harris, T.M. and D. Weiner, 1996. “GIS and Society: The Social Implications of How People, Space, and Environment are Represented in GIS.” Technical Report 96-7. Santa Barbara, CA: National Center for Geographic Information and Analysis.

Harris, T.M., D. Weiner, T.A. Warner, and R. Levin. 1995. “Pursuing social goals through participatory GIS? Redressing South Africa’s historical political ecology.” In J. Pickles, editor, *Ground Truth: The Social Implications of Geographic Information Systems*. New York: Guilford Press.

Kishor, P., B.J. Niemann, Jr., D.D. Moyer, S.J. Ventura, R.W. Martin, and P.G. Thum, 1990. “Lessons from CONSOIL: Evaluating GIS/LIS.” *Wisconsin Land Information Newsletter* 6:11-13.

Lang, L. 1995. “The Democratization of GIS,” *GIS World* 8, 4: 62-67.

Leary, M.E. 1988. “Knowledge and Reasoning in Development Control and Urban Design: an Expert Systems Approach,” *Environment and Planning* B 15, 383-398.

Lopez, Xavier R. 1994.“Balancing Information Privacy with Efficiency and Open Access,” *Government Information Quarterly* 11(3), 255-260.

Moyer, D.D. 1975. “Problems of Landownership Data and Related Land Records,” in *Data Needs and Data Gathering for Areas of Critical Environmental Concern: Part 2: Selected Papers from State Programs.* Institute for Environmental Studies Report 54. University of Wisconsin-Madison.

Moyer, D.D. 1977. *An Economic Analysis of the Land Title Record System,* Unpublished Ph.D. Dissertation, University of Wisconsin - Madison.

Moyer, D.D. 1990. “Why Implement a Multipurpose Land Information System,” Chapter 7 in Brown, P. M., and D. D. Moyer (Eds.) *Multipurpose Land Information Systems: The Guidebook.* Washington, DC: Federal Geodetic Control Committee.

Moyer, D.D. 1993. “Economics of MPLIS: Concepts and Tools,” Chapter 15 in Brown, P. M., and D. D. Moyer (Eds.) *Multipurpose Land Information Systems: The Guidebook.* Washington, DC: Federal Geodetic Control Committee.

Moyer, D.D. and B.J. Niemann. 1990. “Economic Impacts of LIS Technology on Sustainable Natural Resource and Agricultural Management,” Proceedings of the Annual Convention of the ACSM-ASPRS, Volume 3, 221-230.

Moyer, D.D. and B.J. Niemann. 1991. “Economic Impacts of LIS Technology Upon Sustainable Natural Resource and Agricultural Management,” *Surveying and Land Information Systems*. 51, 1: 17-21.

Naisbitt, J. 1998. “John Naisbitt: High Tech/High Touch,” Government Technology. 11, 11.

Nieman, Thomas J., Diane Meshanko and Julian Tackett, 1984.”An Analytical Approach to Weighting Objectives for Landuse Planning Decisions,” Research Paper No. 84-10-35, Kentucky Agricultural Experiment Station: Lexington, Ky..

Nijkamp, P., P. Rietveld, and H. Voogd. 1990. *Multicriteria Evaluation in Physical Planning*. North Holland: Amsterdam.

Obermeyer, N.J. 1990. “Bureaucratic Factors in the Adoption of GIS by Public Organizations,” *Computers, Environment, and Urban Systems,* 14, 3.

Onsrud, H.J. 1989. “Use and Value of Geographic Information: Initiative Four Specialist Meeting,” NCGIA Technical Paper, Report and Proceedings, compiled and edited by H. J. Onsrud, H. W. Calkins, and N. J. Obermeyer. Santa Barbara: National Center for Geographic Information and Analysis.

Onsrud, H.J. 1995. “Experiences in Acquisition, Implementation, and Use of GIS in U. S. Local Governments: A Sampler of Academic Studies and Findings.” Co-Authors: B. Azad, M. Brown, Z. Budic, H. Calkins, D. Godschalk, S. French, J. Johnson, B. Niemann, J. Pinto, B. Sandberg, S. Ventura, R. Wetherbee, L. Wiggins. Proceedings from the Annual Conference of the Urban and Regional Information Systems Association. pp. 626-636.

Onsrud, H.J. and G. Rushton, eds. 1995. *Sharing Geographic Information Systems*. New Brunswick, New Jersey: Center for Urban Policy Research.

Onsrud, H.J. and J.K. Pinto. 1993. “Evaluating Correlates of GIS Adoption Success and the Decision Process of GIS Acquisition,” *URISA Journal* 5, 1: 18-39.

Onsrud, H.J., J. Johnson, and J. Winnecki. 1996. “GIS Dissemination Policy: Two Surveys and a Suggested Approach,” *URISA Journal*. 8, 2: 8-23.

Onsrud, Harlan, Jeffrey P. Johnson, and Xavier R. Lopez. 1994.“Protecting Personal Privacy in Using Geographic Information Systems,” *Photogrammetric Engineering and Remote Sensing* 60(9): 1083-1095.

Pickles, J., ed. 1995. *Ground Truth: The Social Implications of Geographic Information Systems.* New York: The Guilford Press.

Pinto, J.K. and H.J. Onsrud. 1995. “Sharing Geographic Information Across Organizational Boundaries: A Research Framework,” 1995 Annual Conference Proceedings of the Urban and Regional Information Systems Association. pp. 688-94.

Poe, G.L., R.C. Bishop, and J.A. Cochrane. 1992. “Benefit-Cost Principles for Land Information Systems,” *URISA Journal*, 4, 2: 20-31.

Poiker, T. and E. Sheppard, eds. 1995. GIS and Society. *Cartography and Geographic Information Systems*, special issue 22 (1).

Portner, J. 1982. “Beliefs Regarding Issues Relating to Land Records.” Unpublished M.S. Thesis. University of Wisconsin-Madison.

Portner, J., and B.J. Niemann, Jr. 1983. “Autonomous Behavior: Its Implications to Land Records Modernization in the United States,” in Proceedings of the XVII International Congress of Surveryors (F. I. G.), Sofia, Bulgaria, June 19-28.

Portner, J., and B.J. Niemann. 1982. “Beliefs Regarding Issues Relating to Land Information,” Proceedings from the Annual Conference of Urban and Regional Information Systems Assoc., pp. 325-31.

Rogers, E.M. 1995. *Diffusion of Innovations.* New York: The Free Press.

Roitman, Howard. 1990. “Legal Issues in Providing Public Access to an AMS: Case Studies and Variances,” *URISA Journal,* 2, 1: 38-45

Schroeder, P.C. 1997. “GIS in Public Participation Settings,” Paper presented at University Consortium for Geographic Information Science (UCGIS) 1997 Annual Assembly and Summer Retreat, Bar Harbor, Maine.

Sieber, Renee. 1997. *Computers in the Grass Roots: Environmentalists, Geographic Information Systems, and Public Policy.* Ph.D. Dissertation. Rutgers University, New Brunswick, NJ.

Seo, Fumiko, and Masatoshi Sakawa. 1988. *Multiple Criteria Decision Analysis in Regional Planning: Concepts, Methods, and Applications,* Dordrecht: Kluwer Academic Publishers.

Sheppard, E. 1995. “GIS and Society: Toward a Research Agenda.” *Cartography and Geographic Information Systems* 22(1): 5-16.

Steger, W.A. 1991. “AFramework to Value Information Systems,” *URISA Journal,* 3, 1: 33-42.

Sullivan, J.G., J.C. Clapp, and J. McLaughlin. 1985. “Toward a Method for the Evaluation of Multipurpose Land Information Systems.” Proceedings of the Urban and Regional Information Systems Association. Vol. 1. pp. 1-10.

Tulloch, David. 1997. *A Theoretical Model of the Life Cycle of Community Multipurpose Land Information Systems Development.* Ph.D. Dissertation in Land Resources, University of Wisconsin-Madison.

Tulloch, D.L., and B.J. Niemann Jr. 1996. "Evaluating Innovation." *Geo Info Systems* (September).

Tulloch, D.L., E.F. Epstein, B.J. Niemann. and S.J. Ventura. 1997." Multipurpose Land Information Systems Development Bibliography: A Community-wide Commitment to the Technology and its Ultimate Applications." National Center for Geographic Information Analysis Technical Report 97-1. Santa Barbara, CA.

Tulloch, D. L., D.D. Moyer, and B.J. Niemann. 1998. "Modernizing Dane County's Register of Deeds: Saving Property Owners $6 Million," *Land Information Bulletin*, No. 1.

Ventura, S.J. 1995. "The Use of Geographic Information Systems in Local Government." *Public Administrative Review*, 55(5): 461-467.

Weiner, D., T.A. Warner, T.M. Harris, and R.M. Levin. 1995. "Apartheid Representations in a Digital Landscape: GIS, Remote Sensing and Local Knowledge in Kiepersol, South Africa." *Cartography and GIS*, 22(1):30-44.

Zwart, P. R. 1988. "Some Observations on the Real Impact of Integrated Land Information Systems Upon Public Decision-Making in Australia." Proceedings of the Annual Conference of the Urban and Regional Information Systems Association. Vol. 1, pp. 68-79.

Zwart, P. R. 1991. "Some Indicators to Measure the Impact of Land Information System in Decision-Making," Proceedings of the Urban and Regional Information Systems Association, Vol 2.

Zwart, P. R. 1993. "Embodied GIS - A Concept for GIS Diffusion," in *Diffusion and Use of Geographic Information Technologies*, I. Masser and H. J. Onsrud (eds.) 195-204.

Zwart, P. R. 1994. *Land Information Systems and the Public Policy Process.* Ph.D. Dissertation, University of Tasmania, Hobart, New Zealand.

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