GIS and Society:

The Social Implications of How People, Space, and Environment Are Represented in GIS

Scientific Report for the Initiative 19 Specialist Meeting

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EXECUTIVE SUMMARY

The Initiative 19 specialist meeting was structured as a workshop and organized to allow maximum discussion and debate on the broad conceptual issues of 'GIS and Society'. Subsequently, workshop participants sought to identify critical research topics and specific projects. In this way, a research agenda was identified and steps were taken toward the design and implementation of a number of specific research projects.

The workshop brought together researchers and graduate students from the US and Europe and represented a spectrum of the Geography discipline. Deliberations began in an opening plenary session where the steering committee identified three core I-19 conceptual issues: 1) *epistemologies of GIS*; 2) *GIS, spatial data institutions, and access to information*; and 3) *developing alternative GISs*. Subsequent small group and plenary discussions generated the following seven research focus areas:

* GIS 2 and virtual geographies
* GIS social practice and intellectual history
* Environmental justice and political ecology
* GIS in the community: local knowledge and multiple realities
* Data access, privacy and geodemographics
* Gender and representation
* Geographic Information (and Systems) and the human dimensions of global environmental change

An agenda for research was identified for each of these seven focus areas and specific research perspectives and projects began to emerge. To date, the following four group projects initiated at the workshop are underway:

* The Social History of GIS
* The Ethics of Spatio-Visual Representation: Towards a New Mode
* A Regional and Community GIS-based Risk Analysis
* Local Knowledge, Multiple Realities and the Production of Geographic Information: A Case Study of the Kanawha Valley, West Virginia

Proposal writing for additional funding support for these four projects is underway. A proposal for a related GIS and Society research project in South Africa has successfully obtained NSF funding and that research will begin on January 1, 1997.

Another immediate outcome of the I-19 workshop has been the Public Participation GIS Workshop held at the NCGIA site at Orono, Maine (July 10-13, 1996). This workshop explored further the social and technical limits of GIS production and use. Other I-19 workshop outcomes include: organization of several conference special sessions and paper presentations; maintenance of the I-19 WWW page (http://www.geo.wvu.edu/www/i19/page.html); expansion of research networking and collaboration; and commitment to revise the NCGIA GIS curriculum regarding Society issues. The   I-19 steering committee is also collaborating with the University Consortium of GIS (UCGIS). The peer review publication of research results is ongoing.

SUMMARY OF INITIATIVE 19 WORKSHOP

Introduction to the I-19 Specialist Meeting

NCGIA Initiative 19, 'The Social Implications of How People, Space, and Environment are Represented in GIS', was conceived during the November 1993 Friday Harbor NCGIA sponsored meeting on 'Geographic Information and Society.' The meeting was organized by Nick Chrisman, John Pickles, Tom Poiker, Eric Sheppard and others, at a time when there was a need to bring together 'GIS practitioners' and 'social theorists.' The meeting was held in a positive and amicable environment and has subsequently laid the basis for the I-19 proposal to the NCGIA. Fourteen attendees at the Friday Harbor meeting were present at the I-19 specialist meeting.

Contemporaneously with the organization of I-19 came the publication of two important 'GIS and Society' publications: *Ground Truth: The Social Implications of Geographic Information Systems,* edited by John Pickles; and a special issue of the journal *Cartography and GIS* (*CAGIS)* which arose out of the Friday Harbor meeting and was edited by Eric Sheppard and Tom Poiker. Both these publications stimulated important debate which provided the conceptual core of the I-19 proposal to the NCGIA (see Appendix A).

The I-19 specialist meeting was organized as a workshop with a combination of group plenary sessions and smaller focus group sessions. The workshop began with discussions around I-19 conceptual issues and then shifted to potential research focus areas. Emphasis was placed not on formal presentations but on plenary and small group discussion. Rapporteurs reported back to the main plenary sessions from break-out sessions, and by regularly changing the composition of the small groups, maximum interaction was ensured. Toward the end of the workshop, the format became less structured to allow for groups to develop around specific research projects.

Conceptual Issues

During the opening plenary session, it was proposed that GIS represented a set of social practices and institutions embedded within a particular discourse. In this respect the origins and epistemologies of GIS; the political economy of information and information access; the nature of GIS representations; the relations between spatial information types; and the ethics of information, were all identified as essential elements for 'GIS and Society' discussion and debate. GISs are thus institutionalized within systems of data and situated within particular economic, political and legal structures. They can, therefore, be considered as spatial data institutions. To further focus the discussion, three broad I-19 'GIS and Society' conceptual issues and sets of related questions were identified.

Epistemologies of GIS

If GIS is concerned with an abstraction of the real world and with its representation in digital form, then what are the critical issues regarding inclusion or exclusion of various forms of knowledge? The concern here is with how the world has been represented in various systems of GIS and geographic information and how these systems have evolved and been fashioned over time. What, for example, have been the implications for the development of GIS arising from circumstantial decisions made early in the evolution of GIS? What limitations or opportunities for GIS arose as a result of these early decisions? What are the *silences* in our representations in GIS and what areas of knowledge or forms of knowledge have been privileged and excluded over others as a result of the evolutionary tract that GIS has taken? What power relations in society are embedded within existing GIS epistemologies?

GIS, Spatial Data Institutions, and Access to Information

These issues were again best captured in a series of questions. How do institutions that produce and disseminate spatial information impact patterns of spatial information access and use? Is access to geographical information socially differentiated and if so in what way? Who has privileged access to spatial data and what happens to non-standardized forms of spatial information in a GIS? How do the socio-economic and political positions of spatial data institutions impact the ways that GISs are built and used? Are public sector applications fundamentally different than private sector applications? Linked to these questions are embedded concerns for personal privacy and intrusion and the use of closed and open systems of proprietorial data and knowledge.

Developing Alternative GISs

Arising from an understanding of social impacts on existing uses of GIS is a concern to address these issues and consider how 'alternative' forms of GIS production, use, access, and representation, could be pursued? Could a 'bottom-up' GIS be developed successfully and what might it comprise? How can community participation be more fully incorporated into a GIS and to what extent would such participation serve to legitimize conventional top-down decision-making? What policy impacts might arise for GIS containing conflicting information associated with the inclusion of multiple realities of space? What are the potential implications for the inclusion of ambiguous or even contradictory data? What are the implications for using GIS for decision-making and conflict resolution, particularly if the GIS has to contend with non-commensurate value systems. Equally important are the implications arising from a spatial information system which is broadly available to all user groups rather than to a segment of society as tends to be the case currently.

These three broad 'GIS and Society' issues set the tone for subsequent workshop discussion. Further debate ensued as to how these questions and issues might be pursued and under what discursive frameworks. The workshop schedule thus focused on:

1. Defining, Refining and Altering the Conceptual Foci;
2. Identifying Specific Research Themes and Questions; and
3. Establishing Concrete Research Projects

Summary of Plenary and Small Group Discussions on Conceptual Issues: I

I-19 conceptual themes were discussed within four small groups. Later, these groups reconvened in plenary session and reported back. Conceptual issue # 1 from the original proposal questioned:

> *In what ways have particular logic and visualization techniques, value systems, forms of reasoning, and ways of understanding the world been incorporated into existing GIS techniques, and in what ways have alternative forms of representation been filtered out?*

Group A Report

This group began with a discussion of how particular logics have been excluded from GIS; how they might be included in GIS; and how GIS has been linked to the enlightenment project of modern cartography. In discussing why a particular visualization system has become privileged, two perspectives emerged: (1) GIS represents a powerful analytical tool that produces useful results; and (2) GIS is a Cartesian model of space which excludes certain forms of representation.

Critical questions raised in Group A discussion included:

How can GIS incorporate multiple realities of space especially if the 'facts' may be in conflict but 'true' to different groups. How can excluded voices be incorporated?

Is there a privileging of the visual over other ways of knowing the world?

Can there be technological solutions to these problems?

Can GIS be constructed as a reflective tool; for knowing places more fully, rather than as solely a tool directed toward decision-making?

How does metaphor operate in a GIS? Just as there are levels of metaphor within maps, so there are also systems of metaphor within GIS.

In subsequent discussion, it was suggested that one way of enriching GIS is to think of it as a communication device that currently has a very limited range of symbols. In this way opportunities should be sought to broaden the 'vocabulary' of GIS and increase the choices of metaphors available.

Group B Report

This group focused on the various ways of knowing the world including gestalt, iconographic, and allegorical ways of knowing. At present these ways of knowing are missing from GIS. A distinction was

made between GIS1, or (most) current GIS practice, and GIS2 which might include forms of knowledge previously excluded from GIS1 while also broadening the societal base of GIS use. In distinguishing between what exists now, and what might be in the future, it was recognized that GIS1 came out of the scientific tradition and adopted the practices of cartography.

On an ontological level, different world views give rise to a variety of visualizations and representations. There is an important distinction to be made between representation and interpretation as well as between representation and communication. At issue, therefore, is much more than viewing GIS solely as a representational system. It is necessary to be precise about what is implied by the terms GIS1 and GIS2. There are different levels of interpretation including the data itself; its use; specific applications; and institutional practices and settings.

From this discussion, critical questions raised within Group B included:

What happens when the 'social world' is translated into existing GIS systems?
What constitutes democratic practice in the context of spatial database development and use?
What opportunities are provided by developing and using a 'sketch map' GIS?
Can new technologies be designed to represent new kinds of objects?
Are communities of interest aggregating themselves in ways other than spatially?
Can there really be a GIS2?

Group C Report
GIS representation needs to be linked to traditions in geography, both old and new. What dimensions of reality cannot be captured adequately by a GIS? What limitations, if any, have been imposed by vendors? In evaluating GIS and Society issues it is important to be reflective and self-critical. There was also discussion of how GIS grew out of map logic.

Group D Report
This group agreed that there are biases inherent in GIS and that GIS is a product of certain kinds of social practices. In the former, these biases come from early decisions made in the evolution of the technology and numerous unacknowledged presuppositions; for example, the nature of objects, assumptions about measurement, the importance of overlays, and how space is conceptualized. There is a need to examine influential early GIS applications such as CGIS, with its focus on land evaluation techniques. Sources of bias also include managerial attitudes and the treatment of nature as a resource for human consumption.

In the latter case, ways of knowing are usually packaged around the managerial and problem solving portion of GIS. There is a need to look equally at issues of explanation rather than just problem solving.

Cultural differences in GIS practice were raised and comparison made between the U.S., where discussions go on concurrently with the GIS construction, and in Germany, where these discussions tend to be held before GIS production begins.

Summary
After each group presented the results of their deliberations, the plenary session discussion focused on five issues:

GIS as a standardized package which has its roots in modern cartography

The nature of spatial data institutions associated with GIS1

The evolution of GIS as social practice

What a GIS2 might look like

The feasibility of developing a GIS2

Summary of Plenary and Small Group Discussions on Conceptual Issues: II

The afternoon sessions for the first day were structured in the same way as those in the morning. Two further conceptual issues from the original proposal provided the focus:

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

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

Group A Report
Group A began by clarifying what was meant by 'access to data'. Access is linked to skill and knowledge. Individuals may have access to data, but lack interpretive skills. If public and private data providers have the opportunity to share data, will they? And when data is accessed, what are the capabilities and possibilities for empowerment? Is the data accessing people rather than people accessing data?

The World Wide Web provides one model of a dynamic, flexible, and available data provider. Is GIS developing 'Web envy'? Can the WWW be the GIS2 of the future? If technology could broaden access to information, will people share?

Group B Report
Discussion began with the following challenge: has GIS influenced any decision made and, if so, how? It was suggested that GIS reifies the ecological fallacy and that the success or failure of data/information in GIS is indeed related to access to data and expertise.

Group C Report
The relationship between information and power was raised in the context of the potentiality of commercial firms marginalizing groups in terms of access to information. Privacy is a critical GIS and Society issue. There is a need for basic information and a need for non-hegemonic representation of geographic information. Could GIS2 be a communication device in this instance?

Group D Report
Consideration focused on current GIS being more space-based than place-based. Discussion explored the development of a Place Information System as being less marginalizing. The flavor of a place is in continual flux and GIS could contribute towards a geography of place and space

Towards a Research Agenda
In the plenary and small group discussions of the above conceptual issues, researchable themes began to emerge. The following seven topical areas constitute the core of the 'GIS and Society' research menu established at the workshop.

> GIS2 and Virtual Geographies
> GIS, Social Practice and Intellectual History
> Environmental Justice and Political Ecology
> GIS in the Community: Local Knowledge and Multiple Realities
> Data Access, Privacy and Geodemographics
> Gender and Representation
> GI(S) and the Human Dimensions of Global Environmental Change

Also emerging from the group discussions and subsequent plenary sessions were the beginnings of more specific research projects which encapsulated aspects of the GIS and Society debate. Summaries of small group research theme meetings were as follows.

GIS2 and Virtual Geographies

The primary focus of discussion was about testing the frontiers of GIS production and use. In seeking to develop a more inclusive and participatory GIS, a starting point could be to ask what aspects of existing GIS should be retained and what aspects should be excluded? Furthermore, there is a need to identify the tensions between what is desirable and what is feasible? A project in this area would need to explore new ways of molding human interactions. There is also a need to look into GIS-Internet applications.

An initiative to identify a set of methods and instruments should become a focus of study in which the GIS became oriented more toward representation, as much as toward the 'representers' themselves. In this respect, knowledge construction would involve moving away from the map as metaphor. Emphasis would be placed upon the role of participants in the GIS; the (equal) representation of diverse views; the integration of system components within a single interface; and the representation of the history of its own development, including a temporal element. Several significant problem areas and questions were identified for investigation as to the extent to which GIS2 would be built upon GIS1; the role of community 'Freenets' and the World Wide Web; how narrative could be incorporated; the development of new methods for negotiated outcomes; how individual interactions might be modeled and preserved within the system; and how a variety of knowledge and representation from participant groups might be included.

GIS, Social Practice and Intellectual History

A comparative study of GIS was proposed which would place GIS within the context of the enlightenment project. How has GIS been institutionalized and what ways of knowing have been incorporated? What were the roads not taken? There is a need for a deep history of GIS which should include an understanding of GIS as a contemporary institution; the histories and intellectual biographies of the principal people involved in GIS development; a cultural geography of GIS; and investigation into the early common assumptions of the GIS creators such as their cultural background, for example. There is also a need for a comparative international study of how planners use GIS.

A critical history of GIS was thus proposed involving archival research and biographical interviews. The methodology was to be mindful of both structure and agency. Three foci were identified for study: 1) identify and examine the institutional and intellectual cradles of GIS; 2) identify key processes in the evolution of GIS and the critical junctures in the development of the technology; and 3) identify the key individuals involved in the development of GIS.

Environmental Justice and Political Ecology

Merging environmental justice and political ecology provides a unique conceptual framework for understanding existing and alternative GIS uses in the broad areas of environmental justice and equity. There is a need to examine environmental equity and justice issues in a spatial context while also

considering the various models and methods that are currently available and in use. There are critical issues about scale, the types and quality of available databases as well as important political-economic considerations about existing GIS uses and representations of space and nature.

There are a number of critical research questions, including:

How is existing geographic information of the environment socially embedded and what political processes help to reproduce hegemonic representations of nature?

What are the ways in which social relations influence the use, access, and ownership of spatial information?

How can GIS contribute to both conceptual and empirical goals of environmental research?

How has GIS influenced the perception of risk?

How has GIS influenced environmental policy struggles?

In what ways can GIS empower and disempower community groups?

How might particular 'communities' be involved in the production and use of GIS?

How can equity issues be examined in a spatial context?

Is GIS sensitive to non-Western notions of nature?

Three teams - from the Universities of Minnesota, South Carolina, and West Virginia - will provide a base for collaborative case studies to examine environmental risk, local communities and GIS. A comparative assessment was proposed for the three states, especially with regard to positional accuracy and how local communities are involved and/or marginalized from existing GIS-based efforts. This project is concerned with how GIS is being used to monitor, represent, and model real and potential toxic releases. Other concerns include: how scale and representation influence the generation of risksheds and their perception by people; how toxic hazards impact the quality of life in places subjected to releases and how residents mitigate them; and how data flow and representation influence local response to toxic sites? This project is also concerned with alternative community-based GIS development.

GIS in the Community: Local Knowledge and Multiple Realities
This research theme focused on how local knowledge and multiple realities of space and environment at the level of the 'community' could be incorporated within GIS. This raises some questions concerning the potential role of academics in community work; the extent to which current spatial data institutions impose constraints on successful community scale applications; and, the potential role of community groups and non-profit organizations. Specific questions which emerged from this group discussion include:

How do existing GISs impact specific communities?

In what ways might community social differentiation influence the effective development and use of a GIS?

What kinds of questions, needs, and problems do communities have and how might spatial information and GIS analysis help?

What is the relationship between academics/GIS providers and specific community needs?

How might academic activism help communities and what are the possible consequences of mapping data in different ways?

Data Access, Privacy and Geodemographics Focus Group

We are a society with increasing quantities of data at multiple levels of availability. Data availability is increasingly accepted and expected. As a result there is an increasing capability for technological surveillance. Are there ways to ameliorate concerns about surveillance and the role of GIS? How might fair information standards be imposed or included in a GIS? How might these issues of privacy be pursued in commercial and government institutions? Three sets of questions would guide this research area:

Are there techniques that might diminish problems of slanderous labeling and stigmatization? Are there technological fixes and can there be a resolution to these problems even in a non-technological way?

To what extent is it possible to enforce fair information standards in GIS? (Geographic data often breaks down an individual's control on data.)

How do we resolve questions of privacy at the intersection of government and commercial data, as the boundaries between government and commercial data become increasingly blurred?

Gender and Representation

Two potential research foci were identified: (1) the lack of participation of women in the GIS production process (which some participants challenged); and (2) the extent to which womens' space was being represented and/or marginalized in existing GISs. The initial concern raises questions about whether inherent mechanisms in the industry exclude women from entering or performing on a par with males and whether the possible deskilling of the technology would generate increased female employment. A feminist critique of the GIS production process was thus proposed. Issues surrounding the representation of gender and sexuality (as well as class, race and ethnicity, and other types of identity) are, of course, fundamental 'GIS and Society' research concerns.

Feminist critiques of science are also important. Relevant questions include:

What are the limits and potential of GIS for representing women's worlds?

What might a feminist critique of GIS look like?

What might a feminist GIS look like?

GI(S) and Human Dimension of Global Environmental Change

A number of issues previously discussed were contextualized at the global scale as to how GIS was being utilized to represent the human dimension of global environmental change. Major questions include:

What kinds of geographic information and GIS applications are being prioritized in current human dimensions of environmental change research?

What kinds of particular descriptive, explanatory, and evaluative features characterize the representation of global environmental change implicated in these GI(S) efforts, and what kinds are de-emphasized or excluded?

What are the socio-political and environmental implications of global environmental change policy formulation and its implementation at the international, national, and regional scales?

How might problems suggested in the above be addressed in human dimension of environmental change research?

The Way Forward

The above research foci provide the essential elements of a research agenda upon which individuals and groups can build. Initiative 19 now becomes an umbrella for the implementation of research (see proposals below) and the continued networking of individuals and groups. The Public Participation GIS workshop held in Maine subsequent to the I19 specialist meeting is an important example of the latter (see section below). In addition to these activities, I19 will:

- hold a subsequent workshop and conference in late 1997
- submit research proposals to NCGIA
- submit research proposals to other funding agencies
- maintain the WWW link at WVU for dissemination of information and flow of discussion
- develop individual research clusters as outlined above and to broaden the discussion to include as many contributors as possible
- reach a broader audience in Geography and related disciplines as to the issues raised by the Initiative
- revise the GIS curriculum to include GIS and Society issues.

INITIATIVE 19 RESEARCH PROJECTS

Immediately after the specialist meeting, four research proposals were submitted to the NCGIA for funding by workshop participants:

- The Social History of GIS
- The Ethics of Spatio-Visual Representation: Towards a New Mode
- A Regional and Community GIS-Based Risk Analysis
- Local Knowledge, Multiple Realities and the Production of Geographic Information: A Case Study of the Kanawha Valley, West Virginia

These projects were favorably reviewed and have begun. A summary of each proposal follows.

The Social History of GIS

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Introduction

At the heart of the research we propose are questions related to the I-19 proposal. First, how have particular logics, technological developments, visualization techniques, ways of knowing, and forms of reasoning entered into contemporary GIS; how they have come to function in specific institutional and practical settings; how certain possible pathways were taken; and what alternatives were available that for one reason or another were not taken (conceptual issue 1, p.5). Second, in what ways have particular systems and uses of GIS resulted in differential levels of access to information. Specifically, we will address the need for "an historical analysis of the ways in which GIS have developed and diffused (who funded development, what options were considered and rejected, what institutional and intellectual linkages were forged in the development of GIS, etc.) and empirical analysis of contemporary patterns of production, marketing, and use" (conceptual issue 2, p.7). The project also deals with the institutional settings within which GIS is practiced and asks to what ends is GIS put, and what notions of access, representation, and use underpin these practices

The Social History of GIS Group begins its analysis with a simple conceptual distinction which is important for the way in which our research agenda is framed. This is between, on the one hand, those GIS which, because of logics adopted, ways of knowing accepted and rejected, technologies developed and used, and institutions built, function in a way that homogenizes the world and reduces it to a set of particular logics and representations - the *homogenizing influence of GIS*. On the other hand, GIS displays a great deal of internal variability in its application in particular geographic and social settings. This variability should not be overlooked or denied. The variability-in-use points to important possibilities that we need to recognize within I-19. We call this the internal variability of GIS and the geographical variability of GIS practice.

Research Issues

It is our task in this group to focus on the 'ways of knowing' that have come to characterize GIS practice, and to try to identify the ways in which certain roads were

taken and not taken. The I-19 Specialty Meeting Working Group on the Social History of GIS identified three project areas as part of a critical social history of GIS on which we felt work was needed. This proposal outlines these three project areas, and specifies one for immediate funding support.

1. Precursors and preconditions for the development of GIS.

The intellectual and technological 'prehistory' of GIS; how GIS fits into the post-Enlightenment project; premodern and early forms of GIS. These issues require a 'deep history' of how systems of representing geographic information developed, such as metrication, land surveys, military surveillance, and mapping expeditions. That is, what were the precursors and ways of understanding the world that provided the conditions of possibility for GIS to emerge in the forms that did?

2. Applications of GIS in different cultural and political economic contexts.

As noted above, GIS is not a single, homogenous set of technologies and practices. There is enormous internal variation within the rubric captured by "GIS", and there are important differences in the ways in which GIS functions as a social practice. That is, there is a sociology, political economy, and geography of GIS development and use. In this part of the research we propose to study some of the ways in which different geographical, institutional, and social settings have produced different types of GIS theory and practice.

3. The development of contemporary GIS systems.

One important way in which we will be able to investigate how contemporary GIS came to be the way they are is through an ethnographic analysis of contemporary developers and uses. Whether and how did different institutional and individual interests involved in the development of the technology lead to particular innovations and affected their

subsequent development? How a community of theoreticians and practitioners developed to promote a particular version of the technology? Three "sites" seem to be particularly important in this regard:

a. Key institutions: which institutions provided an intellectual and material context for the development of GIS and how did their interests, operations, and 'ways of life' affect the development of technology?

b. Key processes/events: where were the main critical theoretical and technological turning points in the development of GIS technologies, how did these occur, and how did they affect further development.

c. Key individuals: who were the main actors in GIS and how did their personal experiences, motivations and decisions affect the evolution of the technology and its institutionalization?

Research Design

We propose to carry out a series of in-depth interviews with individuals whose work defines particular aspects of GIS as social practice. The sites for study will be:

- NCGIA

- Leaders in GIS field in geography (for example, at IDRISI, etc.).

- Commercial software developers (for example, ESRI).

- Bureau of the Census (particularly the development of DIME and TIGER).

- Geodemographic marketing firm (Claritas).

- Defense Department (specifically the negotiating team and technical support staff for the Dayton Peace talks of 1995).

Each 'site' will be investigated by a team of researchers combining GIS experts and social theorists. Research methodologies will involve literature reviews, archival research, and in-depth interviews. Interviews will be carried out to provide a common database (transcripts will be distributed to the research team and others through the WWW), and individual researchers will use these common "data sources" for their individual analysis.

Individual team members will write individual and/or co-authored research papers focusing on questions specific to their own interests and expertise. Topics identified for study include (but are not restricted to):

- choices of technology and logics along the way.

- public-private relations in the development of GIS technology.

- the political economic context of the development of GIS.

- the 'discourse' of GIS technology.

- the representation of women in the GIS community.

- the different institutional contexts of GIS use (research, marketing, Defense, etc.).

The Ethics of Spatio-Visual Representation: Toward a New Mode

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Introduction

Among the most important consequences of the development of geographic information systems is the widespread ability of those in government and business, as well as the public more broadly, to create spatial representations. One consequence of the ability to create these representations. These issues arise in a number of arenas. Perhaps most obvious is the area of medical data. There the easy availability of data on stigmatized diseases or, potentially, on genetic propensity to disease creates the possibility for misuses damaging to individual and neighborhood alike. Similar issues arise in the case of geodemographics.

This project is an attempt to make sense of the problems posed by these spatio-visual representations. Its aim is to suggest ways in which the existing regulatory framework can be improved, so that the right to privacy and the right to know are better balanced.

Current Practice

Current practice with respect to spatio-visual representations can perhaps best be seen as growing out of the intersection of three roots. First are a very general set of common-sense principles and practices associated with what might be termed

"cartographic ethics." In this category are included the homilies and exhortations that are taught to those learning to produce or read maps--one needs to use due diligence, to be accurate, to be careful in generalizing, and so on.

A second root of current practice has developed in the United States Census, and in the systems established for the protection of individual records. Over the last several years the Bureau has developed increasingly sophisticated tools, designed to prevent data users from working backwards from aggregate results to individual cases.

A third root of current practice, one related to the last, is the legal and regulatory framework surrounding any release of certain forms of data. For example, by state statute medical data typically may not be released for small geographic areas. Here, too, regulations designed for data released in any form have implications for those data once they are released in the form of maps.

The first part of the project will address current practices of spatio-visual representation. It will address the following questions:

- What are those practices, as expressed in standard textbooks, professional codes, and the like?

- In what ways have government and other organizations used formal (technical and non-technical) systems for the protection of individual data? How have they mandated the nature of representations of these data? What alternative methods are used in other countries?

The Limits of Current Practice
- The second part of the project will develop a more thoroughgoing analysis of these and other limitations. It will do so by addressing the following questions:

- What can we learn from the broader literature on the ethics and law of non-cartographic visual representations, such as photographs?

- In what ways relevant to the ethics of spatio-visual representation do the existing ethics of cartography and geographic information systems appeal to outdated or irrelevant images of the nature and place of representation?

- In what ways does the spatiality of data render ineffective or inadequate the traditional methods of data masking?

- In what ways do normal methods of map reading involve unwarranted or unintended inferences, and are there representational practices (associated with scale, manner of generalization, etc.) that can minimize these problems?

On the basis of the answers to the above four questions, the project will finally lay out a general picture of the ways in which one can move from generalized data to cartographic representations, while at the same time minimizing the likelihood of violations of individual privacy.

Methods and Timetable

This is a multidisciplinary project. It will involve the cooperative efforts in the areas of:

- The ethics and practice of cartographic and non-cartographic representation
- The legal regulation of medical and other statistical data
- Spatial statistics
- The psychology of map perception and the visualization of data quality

A Regional and Community GIS-Based Risk Analysis

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Part 1: Assessing community vulnerability at the city-wide level

Over the past twenty years, advances in digital cartography and geographic information systems (GIS) have made mapping and spatial analysis accessible not only to geographers and other spatial scientists, but also to society in general. GISs now can be found in all levels of government and the private sector. Locally, for instance, Hennepin County government maintains a state-of-the-art GIS for property records, criminal analysis, and parks/recreation, while Dakota Electric has developed a detailed spatial database for maintaining public utility records. Concomitantly, the application of geographic information systems to assess environmental and technological risk is increasing. One can find examples of GIS used in assessing the risk from air toxins, monitoring the quality of groundwater, analyzing the human response to earthquakes, and wildfire management planning. In most instances, while the development of a database focusing on the actual risk is adequate, or even quite detailed, the information on the geographic exposure to risk is poorly developed. Accounting for the latter must become an integral component of GIS in the domain of risk analysis.

Our research involves a project that uses geographic information systems (GIS) to analyze technological risk in the Twin Cities area. First, we describe a risk assessment for the Twin Cities area that involves an analysis of the TRI (toxic release inventory) data, gathered under the Community Right To Know legislation, and basic geodemographic characteristics of the Twin Cities, including race, income, and housing data using GIS. This analytical stage will attempt to identify those regions of the Twin Cities most susceptible to an air-borne toxic release. It will be necessary, of course, to also identify regions of the metro area where significant percentages of lower income

and minority groups reside. Such analysis will attempt to identify regions within the Twin Cities that are, according to Massey and Denton "hypersegregated" using measures such as unevenness in the distribution of the minority within the total population, residential isolation of minorities from non-minorities, the degree of clustering of minorities in a single area, the degree to which minorities live near the central business district, and the concentration of minorities into densely-populated neighborhoods. In the few existing studies, including those by McMaster (1991), and Burke (1993), strong spatial associations were discovered between the location of both minority and lower income populations and the location of hazardous materials. This condition has been labeled by some environmental racism , although the term implies a planned positioning of environmental hazards, which may not always be valid. The McMaster study, using grid- based GIS analysis and modeling, found strong correlation amongst minority (including African-American, Asian, and Hispanic) and hazardous materials sites in Santa Monica, California. Applying tract-level analysis of 1990 Los Angeles census data Burke, likewise, found associations amongst TRI (Toxic Release Inventory) sites, lower income groups, and minorities.

Both studies were preliminary, and much work remains in identifying an appropriate conceptual framework and methodology for the identification of, and subsequent mitigation of this problem. In order to account for varying meteorological conditions, our plans are also to include a Gaussian plume-dispersion model in this analysis that will provide the predicted spatial distribution of potential emissions of TRI substances, in parts per million, given specific wind speed and direction, and chemical type and amount. Furthermore, in addition to assessing differences of exposure by class and race, we will analyze the location of and risk faced by institutions housing sensitive populations, such as day care centers, schools, and retirement homes.

The end result of this project will be development of a risk model for the Twin Cities, a spatial analysis of sensitive and minority populations related to this risk, and an attempt to articulate the degree of environmental in justice that results from the storage and manufacture of hazardous materials. An ancillary component of this study will complete a geodemographic analysis at a variety of scales--block, census tract, and

neighborhood--to determine the effect of resolution on risk assessment. Measures for determining the degree of segregation of minority and income groups are not consistent as one moves from the census tract to the block level. With this study we will be able to assess the effects of geographic scale, and of including different geometries (point, line and areal data), on both segregation measures and the correlation between segregation and risk. Such research falls within what is called the modifiable areal unit problem. The careful identification of such segregated populations is, of course, crucial for including societal concerns in risk studies. Research on GIS and environmental justice was endorsed at the Annandale Specialist Meeting as one of five major areas of the research agenda.

Part II: grass-roots groups and GIS-based environmental information

In assessing environmental hazards, one of the least researched areas to date has been the ways in which participatory democratic organizations (hereinafter referred to as grassroots organizations) make use of spatial information in their attempts to identify, assess, and deal with technological hazards, either existing or proposed. Making use of the GIS developed for TRI sites in the Twin Cities, developed in Part 1, we propose to examine whether and in which ways grassroots organizations utilize available spatial information in dealing with technological hazards.

The research problem is complicated by the fact that we need to deal with at least two major types of grassroots organizations: environmental movements (which may have more general, and less locality-based interests); and neighborhood organizations and other urban social movements whose thematic interests may be much broader than those of environmental groups, but whose level of spatial organization tends to be more localized. In addition, these different types of groups may differ from one another in having different levels of access to GIS-based information (or the technology and skill needed to interpret it). Thus, we can conceptualize our proposed research as examining a four-cell matrix, using comparative case studies to look at organizations

with broad environmental agendas or with more neighborhood-based concerns, each of which may have high or low levels of access to GIS.

For grassroots groups identified as case studies, we will pursue the following questions:

1. *Grassroots perceptions and environmental information*
What are the perceptions of, and knowledge about, environmental hazards that are held by members of the group? What kinds of information do they consider important in thinking about environmental hazards?

2. *Accessibility to and use of GIS*
What uses do grassroots groups make of GIS-based information and analysis? Is a failure to utilize this, or a tendency to subcontract such work to external professionals, a result of lack of GIS expertise, lack of resources, lack of access to data, or beliefs about the irrelevance of such information?

3. *Perceptions among grassroots groups of the usefulness of GIS-based information*
Are the existing GIS-based public data systems relevant for the agendas and concerns of grassroots groups? What other information/analysis is relevant, and (how) can this be integrated with the GIS? Will GIS have to be redesigned (i.e., GIS2) in order to make it an appropriate technology for integrating community understandings of and knowledge about toxic waste with the information provided from public data bases?

4. *GIS and grassroots participation in the decision-making process*

How is GIS-based information used by grassroots groups in presenting their arguments and to what extent does it lead to increased influence over the decision-making process?

5. *GIS as a conflict resolution tool?*

What is the potential of GIS-based information in mediating conflicting positions in negotiations among grassroots groups, private firms and state institutions.

6. *The impact of GIS on the mission, activities and legitimacy of grassroots movements*

To whom in grassroots organizations is GIS based information and analysis made available, and in which ways? How does the acceptance and use of GIS affect the overall goals and internal dynamics of grassroots movements? Based on existing research in organizational sociology and social movements, several possible consequences of the implementation of GIS are possible: (1) A shift in mission, as use of GIS encourages grassroots groups to become more instrumentalist in their thinking, and thus more in conformity with the approach of public agencies or private firms with which they are in negotiation; (2) A split developing within the movement between more technocratic groups, who have become expert in and committed to the new technology and others who resist its application and relevance (which in extreme cases can disrupt the effectiveness of the entire organization, or its legitimacy for its constituency), or; (3) a marginalization of local knowledges and other community perspectives that cannot easily be integrated into the technology.

These questions are not all of equal relevance in all case studies. Question 1 may be of little relevance for organizations which already have adopted GIS, whereas questions 4-6 are likely to be premature for organizations which have not yet adopted GIS. Yet,

taken together, they represent a range of issues about which we need more understanding as we consider the relevance and use of GIS for community and other grassroots organizations. GIS and community represents a second area highlighted in the research agenda developed at the Annandale Specialist Meeting, and we anticipate working with others expert in these areas to develop detailed methodologies for investigating these questions.

We envisage employing two principal research strategies to explore these questions. First, focus groups and intensive interviews with members of environmental groups and neighborhood organizations will be employed to examine issues of perception of environmental hazards, access to and usefulness of GIS-based information and analysis, and perceptions about and experiences of the use of GIS in decision-making and conflict resolution. Second, in order to gain a better understanding of the potential and limitations of GIS in decision-making and conflict resolution, particular selected cases will be investigated using participant observation, detailed documentation of events, debates and negotiations between the parties involved. We currently are developing cooperative work with Citizens for a Better Environment Minnesota, whose attempts to establish Good Neighbor Agreements between urban neighborhoods and manufacturers of toxic waste represent ideal candidates for such case studies.

Local Knowledge, Multiple Realities and the Production of Geographic Information: A Case Study of the Kanawha Valley, West Virginia

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and

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Introduction

The Kanawha Valley, near Charleston (West Virginia), is one of the largest industrial chemical complexes in the world. In 'chemical valley', as it is known locally, the potential for environmental catastrophe combined with numerous more chronic health risks, are very much part of peoples' everyday lives. Risk management and access to information are, therefore, of major importance. The long period over which chemical plants in the valley have caused problems for residents through accidental emissions and long-term background emissions, and the close proximity of plants and communities in the valley in part resulting from topographical controls, makes this a particularly suitable site for the study of political economy of information.

The research focus will include an analysis of how people gain access to geographical information and how the representation of that information impacts the perception and management of environmental/technological risk. Specifically, this includes investigating the ways in which GI and GIS production processes transform existing power relations and how access to chemical hazard information influences risk perception and management. We will investigate the extent to which geographical

information has been made available, is available, could be made available to the citizens and community groups of the region, and how this flow and control of information has affected the nature of local, community, and plant struggles over environmental regulation.

Research Objectives

Three broad objectives guide this research. They are:

1. Investigating the geography of communities and plants, and the history of conflict over and resistance to chemical industry pollution. This includes the role played by business, agencies of the state, and citizens groups in mediating these conflicts.

2. Analyzing the ways in which geographical information (ranging from basic maps to plume charts to geographical information systems) has been deployed in the area, the history of these deployments, and the social context within which their deployments have occurred. In particular, we are interested in the role being played by "worst case scenario" and "most likely scenario" planning, and the reporting documents that have been prepared by each company for a select number of hazardous chemicals held on site. This includes understanding the potential policy impacts of geographic information that displays conflicting representations of landscape and a better understanding of the opportunities for, and contradictions with, "democratizing GIS."

3. Broadening the use of computer-based geographical information through a GIS production process that includes community participation. Of particular interest are the ways in which 'voices from below' are digitally represented

and how socially differentiated local knowledge might be incorporated into GIS production and use.

Research Design and Methods

The project will begin with interviews with groups in the area, specifically community groups, agencies, of local and state government, EPA officials, trade union representatives, and the representatives of the chemical industry. We already have good working relationships with the National Institute for Chemical Studies on the campus of the University of Charleston, and we aim to continue and strengthen these links. NICS has produced a great many reports on the situation in the valley over the past decade, has organized many of the mediation sessions between industry and citizen groups, and works closely with local and state government agencies. Their databases and community links will be invaluable to the project.

The next stage will include detailed mapping of the proxemics of plant and community. By mapping of these relations, we aim to identify (in conjunction with archival resources we have acquired and have been working through) the most likely sites of toxic emission impacts and community resistance. Our goal will be to tie the history of community resistance to a survey of community attitudes to available health data in these neighborhoods. This is necessary to provide the social, economic, and geographic context within which the political economy of information -- specifically geographical information -- can be located. Our aim, therefore, is to document the different forms of geographical knowledge and spatial representation deployed by various interest groups and parties in the valley in their attempts to deal with the problem of toxic releases, ambient pollution, regulatory requirements, and community fears. At the heart of this research strategy is the question of the extent to which formal Geographical Information Systems have been used in the region (we know, for example, that several chemical plants have their own GIS systems tied to emission monitoring and emergency response mechanisms) and to what extent they are emerging and being shaped as they emerge as a result of the needs of emission

control and/or community reassurance.   In other words, what forms do systems of managing, representing, disseminating geographical information take at the present time?

We will also ask the question, what alternative forms and uses of GI and GIS are likely to emerge, and what sorts of demands are being placed by community groups on such systems? In other words, we are interested here in trying to determine the extent to which there are in the community any coherent notions of what types of information would be most useful to mitigate hazards and increase the ability of communities and citizens to monitor the practices of their corporate neighbors. To what extent are existing systems of information management embedded in the companies, or in government offices, and to what extent are they made available to the public? From previous interviews with community activists, we know that questions of access, different reporting regulations, and the possibilities of new on-line technologies for the storage and dissemination of geographical and industry data have all been discussed. The West Virginia Department of Environmental Protection, for example, provides on-line users with access to their detailed databases and will even run basic GIS programs for them on DEP computers through remote access.

In this research we will also explore the definitions, perceptions, responses, and mediations of risk associated with the four social categories of capital, labor, community, and the state. Multiple representations of information are essential to such a pursuit. Local knowledge from the community will be obtained through mental maps, oral histories, and workshops within an ethnographic methodological framework. So-called 'expert' knowledge will be obtained from existing spatial information and environmental legislation and regulations as well as primary data collection from persons associated with the (local) state and capital. Participatory workshops will be a central method for incorporating local knowledge into the GIS production process.

Capturing and encoding local knowledge, which is often aspatial and qualitative, represents a significant challenge to this project, and GIS production more generally. From our work to date we are aware that much local knowledge is spatially fuzzy and

does not conform easily to the spatial primitive paradigm of point, line, and polygon employed by GIS. Oral histories and narrative provide some of the most compelling and informative knowledge to come from the interview-survey process. Not least, the anticipated variety, and possibly conflicting responses, from the socially differentiated groups will provide additional complications for incorporation within the GIS.

A final research component will be the development of GIS-interactive multimedia (IM) linkages. In order to include the variety of narratives, oral histories, anecdotal information, sound, text, photographs, sketches, maps, and video clips which are the tangible materials of local knowledge, we seek to develop icon-driven capabilities within the GIS-IM system to access the full range of traditional and local knowledge available for interpretation. The many relationships between geographical location, data, and the several media modes will be established using an authoring system. Data inquiries will be handled using 'hot link' icons from the GIS based on the hypertext concept. This model describes a set of nodes connected by undifferentiated links, where the nodes can be abstractions made up from any kind of text or graphical information elements. The nodes and the associations between them, the links, form semantic units which may express a single idea or simple data element, or a complex unit such as a map, table, or image. The links tie together the various semantic units and provide a means of navigating through the data.

The development of Hypermaps moves beyond the establishment of links between semantic nodes to include links between spatial location and nodes. The ability of GIS to undertake spatial search functions will be linked to the identification of multiple media objects found within the search parameters. Once identified these objects can be retrieved, displayed, or used as signposts to other sources of information contained within the GIS or multimedia database. This logical movement through the information base utilizes the power of GIS and the flexible nature of multimedia to incorporate information in various media. While these linkages will provide significant freedom to explore the informational relationships contained in the database, one of the main issues involved in the design of these systems revolves around the actual organization, management, and content of these nodes and links within the computer environment.

REPORT ON PUBLIC PARTICIPATION GIS WORKSHOP

Prepared by Paul Schroeder, NCGIA and Dept. of Spatial Information
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Soon after the conclusion of the Initiative 19 specialist meeting, members at the NCGIA in Maine began to explore the possibility of allocating visiting scholar funds toward support of a workshop on the theme of GIS2, a thread of discussion throughout the I-19 proceedings. After consultation among NCGIA site directors and with I-19 leaders, this was approved. The workshop was held in Orono, Maine July 10-13, 1996.

The set of concepts that emerged as GIS2 was set in motion early in the I-19 specialist meeting by opening comments from Michael Curry, who described spatial data institutions and posed the question: What could GIS be? Implicit in this question is the critique of what GIS has become, a motivating element in bringing I-19 participants together. The two strands, critique and possibility, marked much of the content of the meeting's discussions. The presentation of five Criteria for the Design of a GIS2 as a research proposal during the final I-19 session was an attempt to create a synopsis of various responses to Dr. Curry's initial question.

Organizers of the Orono workshop sought a substitute for the GIS2 term that could be more self-descriptive when introduced to a wider set of discussants. The workshop theme became Public Participation GIS (PPGIS). Instead of PPGIS replacing the term GIS2 as anticipated by workshop planners, these two terms came to signify an essential distinction in future GIS development, and were discussed throughout the workshop under somewhat contrasting lights. While GIS2 was situated within a framework of specifications to be applied to the future of the technology and its expanded capacities, PPGIS was attached to the particular problems of bringing a wider public into effective use of the technology at whatever level its development may have attained.

Parallel concepts also had marked discussions at Initiative 17 (Collaborative Spatial Decision Making), though they were less oriented toward the general public and policy making focus of PPGIS. Connections to Initiative 21 (Formal Models of Common Sense Geographic Worlds) were also identified. Participants from each of those Initiatives are involved in PPGIS discussions, and were present at the workshop.

The PPGIS workshop was attended by 18 participants, six from Orono as well as 12 from other sites. Of the total, nine had attended I-19, two had attended I-17, and two were leaders of I-21. Several who attended had not been involved in any of these Initiatives.

The workshop's agenda was devised to support open discussion structured around themes suggested by the GIS2/PPGIS concept. Several workshop attendees were asked to present brief, relatively informal statements on topics including urban data sources and uses, dimensions of conflict and dispute resolution, and current technological possibilities. Discussion directed at each topic followed the presentations. All sessions were plenary; breakout sessions of design workgroups were not pursued. As the workshop was conceived as the continuation of a conversation, its outcomes include carrying that conversation forward into other forums.

The theme of collaborative work and public process was reflected in the creation of an online forum for premeeting discussion of topics proposed for the workshop. Five open question situations were elaborated in forum-based texts, and comments were elicited. The possibilities and limitations of this approach were reviewed during the meeting.

The observed need to extend collaborative models toward communities and the general public led to discussion of the creation of community learning centers. These new institutions, expanding on the strengths of existing public institutions such as schools, libraries and town halls, would create a problem-solving context capable of linking spatial technologies with other networked information resources and utilities, all managed within a framework of user-oriented process priorities.

Further elaboration of the GIS2 and PPGIS concepts will be presented at the 1997 meeting of the Association of American Geographers. A panel of discussants composed of I-19 leaders will comment on reports from workshop participants. Related presentations are planned for other national meetings. In addition, a meeting has been suggested which would bring together academic researchers, GIS system developers, and grassroots project workers. Assembly of a list or catalog of ongoing projects within the PPGIS framework would be needed before such a meeting could be convened. I-19 participants are already at work in several related settings (see the Kanawha Valley and Twin Cities projects in the research projects section).

Documentation for the Public Participation GIS Workshop is maintained at its Web site:

http://ncgia.spatial.maine.edu/ppgis/ppgishom.html

The site includes background documents (including Criteria for the Design of a GIS2), participant list, agenda, links to related projects, the open question situations, and link to the PPGIS Forum.

The Workshop also is documented in ten 2-hour videotapes, including all presentations and discussion sessions. The 8mm masters will be kept at the Orono site. A VHS copy has been made available for loan. An SVHS format set is also held by the Geography Department at the University of Washington. A summary of the tapes has been distributed to participants and is available on the PPGIS Web site. The tape summary also serves as a brief synopsis of all presentations and topics of discussion.

: INITIATIVE PROPOSAL TO NCGIA BOARD

The Social Implications of How People, Space, and Environment are Represented in GIS

Research Areas Based on the Research Agenda of the NCGIA, as submitted to NSF in 1992/93, this Initiative would address the following issues (listed in order of emphasis in this Initiative):

>3.2   Societal Impacts

>3.2.4 GIS and the social, environmental and policy sciences

>3.2.3 Institutional and organizational issues and impacts

>3.2.2 Legal issues, privacy and user access

>1.2   Data models for Geographic Information

>1.2.1 Dealing with multiple representations

>1.5   Knowledge Representation

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            Trevor Harris (Geology and Geography, West Virginia University)
            David Mark (Geography, SUNY Buffalo)
            Dan Weiner (Geology and Geography, West Virginia University)

Center Participants: David Mark, Harlan Onsrud, Helen Couclelis, Michael Goodchild

Core Planning Group: (in addition to leaders)

            Helga Leitner (Geography, Minnesota)
            Bob McMaster (Geography, Minnesota)

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Duration: 1995-1997

Disciplines to be involved: Primarily geography with researchers from planning and public policy, anthropology, psychology, communication studies, and political science.

I. BACKGROUND

This Proposal for an NCGIA Initiative responds to an agenda developed at an NCGIA sponsored 3-4 day workshop -- "GIS and Society" -- held at Friday Harbor, Washington, in November 1993.   The workshop grew out of discussions among geographers interested in the growing influence and social implications of GIS development and use. The workshop participants recognized at that time the need to continue to develop collaborative research to further pursue questions raised in the workshop, and to ensure an on-going dialogue between those whose primary concern has been GIS development and application and those whose primary concern has been about the effects of its use and the possibility of incorporating different types of knowledge system, broadening access, and permitting a wider range of applications in social and natural settings. This proposal is concerned with developing an initiative in which GIS developers and practitioners on the one hand, and critics and social theorists concerned about GIS development and use on the other hand, can work together to address fundamental issues of what can be represented, how systems are developed and used, and possibilities for broadening involvement and access.   At the Friday Harbor Workshop participants agreed on the importance of these issues, the value of social theoretic critiques of GIS research and applications, that issues raised by social theorists in geography (and beyond) should be addressed within the GIS community, and that the Center should participate in this debate.   The kind of dialogue that took place at the Friday Harbor workshop offers a model of openness to differing perspectives and to critical engagement of the limitations and possibilities of GIS that this Initiative seeks to foster.   The Initiative offers critics and proponents of GIS the opportunity to work together to try to understand and solve problems of fundamental importance to geography and GIS.   The Request for Approval in Principle for this Initiative was submitted to NCGIA in January 1994 and approval was given in May 1994. The title of the proposal was "GIS and Representations of Nature and Society."[1]

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[1] The title of the proposal has been changed from this request for approval in two ways. (1) In response to reviewers' comments, we have focused our research more directly on environmental resources instead of 'Nature', as previously specified. (2) In order to broaden the implications of the proposed research we have more carefully specified two areas of research besides environmental resources: the representation of populations and the representation of locational conflicts. These three areas have some overlapping content, but we prefer to treat them in this way for organizational clarity and practical efficiency.

As an NCGIA Research Initiative, this proposal follows the standard pattern. If approved in detail, the Core Planning Group will oversee the progress of the Initiative. The Initiative will begin with a Specialist Meeting, when the Core Planning Group and the NCGIA will convene 30-40 experts for a 3-4 day period to discuss the subject matter of the Initiative, devise a research agenda in this area for the entire research community, and assign responsibilities and arrange deadlines for completion of work. Participants at the Specialist Meeting will be drawn from a variety of fields (listed earlier).

A period of intensive research lasting approximately two years will follow the Specialist Meeting. This research will take place with collaborative activities both inside and outside the Center, using devices such as small meetings, sessions at conferences, electronic mail discussion groups, and other forms of information exchange. These activities will be organized within one of three related clusters (explained in detail later): contemporary uses of GIS to administer populations (with particular attention to local, regional, national, and international level applications in state and business organizations); locational conflicts involving marginalized groups; and possibilities for incorporating different cultural conceptions of land, resources, and value in GIS (i.e., political ecology and GIS). Each cluster of research activity will address overlapping, but distinct, conceptual questions that focus attention on the limits and possibilities of GIS technology, logics, and practice, as well as addressing issues of property rights, power, representation of knowledge, and access. Each cluster of concrete research activities will be organized and coordinated by members of the Core Planning Group.

The results of the Research Initiative will be presented at national and/or international conferences during the course of the two years. At the end of this period the entire research group of 30-40 researchers will reassemble for a 3-4 day workshop to present their findings, discuss their implications, and compile a final report to NCGIA. A closing report will be submitted by the Core Planning Group to the NCGIA Board of Directors for approval following this meeting. An edited book will be published from the Initiative, along with individual research papers published in professional journals.

As with all NCGIA Research Initiatives, the research agenda laid out in this proposal anticipates the findings of the first Specialist Meeting. It is important that the current planning group not foreclose on the development of a rigorous agenda by the Specialist Meeting. This proposal should, therefore, be seen as setting a broad research agenda for NCGIA approval and specific guidelines for the participants at the Specialist Meeting.

II. PROJECT SUMMARY

The proposed Initiative seeks to focus attention on the ways in which current GIS practices in three areas of application (the administration of populations; locational conflict; and natural resources) incorporate particular conceptions and representations of their objects of study; whether these delimit or exclude certain domains of knowledge; whether they preclude certain types of use; and whether and how alternative possibilities (systems, logics, types of knowledge included, etc.) can be developed that might enable GIS to become more broadly applicable and useful across a wider spectrum of users and practices. We will consider these conceptual issues in all three clusters of research activity, since each addresses important issues about how particular types of object are represented, what types of application are available, and at what scales of activity geographical patterns and processes need to be represented. The central goals of the Initiative are to:

1) Examine how data availability and visualization techniques influence the ways in which natural resources and society are represented in GIS.

2) Examine what limits to representation may be intrinsic to the logic of GIS.

3) Determine how the representations of environment and society in GIS influence the questions posed, and solutions proposed in practical applications.

4) Determine whether and how the knowledge, views, and needs of those affected by the application of GIS can be represented adequately in conflictual social situations where GIS is used as a decision-making tool.

5) Examine to what degree new functionalities of GIS may allow the limits of current representations to be extended.

6) Investigate the degree to which the application of GIS can be democratized by placing the technology in the hands of a broader spectrum of society.

7) Investigate (drawing on Initiative 16: Law, Public Policy and Spatial Data Bases) the ethical and legal implications of the results of pursuing objectives 1-6; concentrating specifically on issues of ethics, democratization, social differentiation, local empowerment or disempowerment, and the potentially conflictual nature of GIS in decision-making, so as not to duplicate the efforts I-16.

III. FUNDAMENTAL SCIENTIFIC QUESTIONS and
STRUCTURE OF THE RESEARCH

Among the range of topics concerning the relationship between geographic information and society discussed at the Friday Harbor NCGIA workshop (Nov. 11-14, 1993) considerable attention was devoted to examining ways in which society and environment are represented in GIS technologies, and the implications of these representations for the application of GIS to the administrative functions of state and business organizations, social groups and locational conflict, and natural resource allocation decisions. GIS represents a cluster of techniques, tools and institutions developed in a particular societal context, and this has influenced the evolutionary paths along which GIS has developed. Since these paths are just some of the many

directions that the technology could have taken, and since a common theme of all GIS is representation of the geography of the world around us, three fundamental questions about representation arise.

The first concerns the limits of representation of populations, locational conflict, and natural resources to be found within current GIS, and the extent to which these limits are extendible by evolving technologies of data storage, manipulation and functionality. Investigation of representations inherent to GIS involves first analyzing the current situation; the mode(s) of reasoning utilized within GIS hardware and software, its functionality, and the influence of data availability and digital representation on system design and output.

The second concerns the impacts of these limits and impediments -- particularly in the context of other societies and of inequalities in access to necessary software, hardware, and technical skills -- on the types of outcomes that result from the application of GIS to decision-making. This issue becomes vital when the groups affected by such decision-making possess opposing interests, unequal access to political or financial resources, or very different ways of perceiving and making sense of the world. Thus, it is important for us consider the possibilities and implications of overcoming these impediments by a *shift of emphasis* from the experts developing and utilizing the technology to those whose actions and lifestyles are affected, knowingly or unknowingly, by such applications. Specifically, it is necessary to examine what types of knowledge and forms of reasoning are not well represented within GIS as used in decision-making situations, the importance of such knowledge and reasoning to a decision-making process in which all viewpoints and social groups are democratically represented, and the consequences of its exclusion from GIS.

The third concerns the need to pay attention to the developing possibilities of the technology, and the degree to which these allow current representations to be transcended and current impediments to be overcome. From a better understanding of these questions it will become possible to make recommendations about the importance of broadening access to GIS, addressing impediments to its uses in decision-making situations involving competing interests and forms of knowledge, as

well as making recommendations about the legal and ethical issues posed by the use of GIS in the contexts under consideration.

For each of these three fundamental questions the Initiative integrates **description** (of the development of particular logics, systems, and uses of GIS), **analysis** (of the limits of access, range of diffusion, and effects of use), and **critique** (focused on the epistemological assumptions embedded in systems and use, conceptions of language in use, and logics and representations).

This proposal is structured in two parts. Part One identifies the conceptual issues and research questions central to the entire Initiative. These have been selected to address issues that pose important challenges for representing geographical objects. Here we identify five key questions, providing the frame within which the three clusters of research will be carried out. Each cluster is designed to permit a diverse coverage of users and needs (state-business, minorities, and resources), and each enables work to consider the uses and impacts of GIS at different scales and among different social groups. Each cluster will be organized to address the five conceptual questions identified below. The first two conceptual questions address the influences of the design and structure of GIS and data bases on these representations. The next two examine the voices and groups excluded from these representations, and the possibilities of including them and democratizing GIS applications. The final one examines ethical implications. Progress on these questions will require a combination of theoretical and historical analyses of representations and their possibilities, with detailed case studies of actual applications and their consequences for all affected groups. Part Two investigates the conceptual questions in Part One through three concrete, related areas of geographic concern (clusters of research): (a) contemporary uses of GIS in the administration of populations in state and business organizations; (b) locational conflict; and (c) the representation of environmental resources.

We have given serious thought to the suggestion of a reviewer of the "Request for Approval in Principle," that the Initiative be split into two, with the first two questions being part of one Initiative and questions 3-5 being part of a second Initiative. There is merit in this proposal, and splitting the two would deal with other concerns about the

ambitious nature of the proposal. However, we feel that the five questions address an appropriate and linked set of issues that must (and can) be asked in combination. We must stress that our intention in this Initiative is focus on the conceptual questions in Part One in the context of concrete projects outlined in Part Two. The projects outlined in Part Two, if developed separately could in several cases stand as separate Research Initiatives. We will limit our own investigations in Part Two to the questions outlined below.

Part One: Conceptual Issues

1. In what ways have particular logics and visualization techniques, values systems, forms of reasoning, and ways of understanding the world been incorporated into existing GIS techniques and in what ways have alternative forms of representation been filtered out.

In this first issue, we wish to clarify the nature of the development paths taken within GIS and to map out possible alternatives that are or may be available. Addressing the choices made and the possibilities not chosen will require a detailed textual reading of the debates and decisions about system choices and foundational logics within GIS over the past 20 years, using published papers and books, conference proceedings, and private papers, bringing together geographers, computer analysts, and specialists in logical systems and representation.

Research into the ways of understanding the world embedded within GIS and the alternatives available will be undertaken by a group of scholars in geography, cultural studies, and communications studies. The aim here will be a thorough investigation of representational logics within spatial data handling technologies, with particular attention being paid to the ways in which we can incorporate alternative cultural and social conceptions of social and natural objects (property, land, resource relational values, historical meaning) within GIS, and the possibilities for extending GIS to incorporate new ways of understanding the world.

In this regard, we will pay particular attention to the extent to which GIS privilege particular conceptions and forms of knowledge, knowing, and language, and the extent to which it is possible in electronic imaging systems to develop the kind of reflexivity that many see as essential to a critical social science. But, as well as considering the ways current systems enable and/or constrain particular representational paradigms, we also will investigate the possibilities and challenges that new technologies such as virtual reality and multimedia pose for current theories of representation.

2. 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?

Differential access to databases is, clearly, becoming one of the central issues facing scholars and users of GIS and all forms of electronic data. As spatial data handling capabilities increase in power, the social impacts become more important. Geodemographic spatial data handling, for example, already is raising serious questions about privacy and access to databases (see Initiative 16).

At the same time, changing technologies also permit new approaches to database monitoring and access. These new approaches may or may not be used to increase the ability of local and regional communities to use GIS. Our concern here will be to develop a series of case studies of particular systems and applications of GIS to investigate the ways in which they deal with issues of privacy and differential access, and the impacts of different approaches to these issues on social uses of the technology. Scholars working in related areas of communications and social policy will work with geographers to develop case studies in different contexts across a range of applications and social uses. Participants will assess whether and how particular ways of constructing systems, adopting logics, and developing databases and applications result in forms of differential access and/or possibilities for wider use and greater empowerment.

As other sorts of media increasingly are incorporated into GIS, and as the systems become at one end more complex and powerful, and at the other more ubiquitous, the

traditional means of imagining the social, economic, and political locus of the map comes to be increasingly irrelevant. The ability of individuals and groups to have access to the output of GIS becomes differentiated in new ways, just as does their ability to understand and act upon that output.

This issue is dealt with substantively in the last two major sections of this Initiative, on political ecology and on locational conflict. In this proposal we are concerned to focus on the extent to which the technological basis and cost of GIS is currently resulting in the democratization of access or the institutionalization of differential access, and specifically on the ways in which the interaction between government and industry (in areas such as research and development, intellectual property, data protection, and standards setting) enable new capacities for action or act to the detriment of groups who are not currently using GIS.

These issues will be investigated first, through an historical analysis of the ways in which GIS have developed and diffused (who funded development, what options were considered and rejected, what institutional and intellectual linkages were forged in the development of GIS, etc.), and an empirical analysis of contemporary patterns of production, marketing, and use. Second, we will examine the extent to which the desire by users of GIS to have standardized systems of data collection and storage conflicts with the needs of other groups of users and potential users, and renders these groups even more marginalized than they already are in scholarly and policy arenas. The relationship between standardization and inclusion will be investigated in the context of case studies which focus on: the extent to which various audiences differ with respect to their abilities to understand the representations generated by GIS; whether differential levels of access and use are maintained as new systems are introduced; and what might be done to minimize these differences in access and broader social inequalities.

3. How can the knowledge, needs, desires and hopes of marginalized social groups adequately be represented as input to a decision-making process, and

what are the possibilities and limitations of GIS as a way of encoding and using such representations?

There are a number of issues concerning the representation of differing forms of knowledge within a GIS. What are the implications arising from digital representations of 'reality' which can impose a particular structure and form of meaning to the decision-making process? Indeed, how does GIS handle multiple versions of reality held by individuals or socially differentiated groups? In the context of incorporating local, non-traditional, forms of knowledge, how can GIS functionality deal with many layers of spatial, temporal and attribute fuzziness? Such issues are fundamental to incorporating a range of social, cognitive, and cultural-ecological information within a GIS.

In addressing the question of how currently marginalized voices can be better included within GIS systems and practices we would stress questions arising from the current nature of GIS: What forms of representation and logic are privileged within contemporary systems of GIS? How is access delimited? What systems of knowledge and what kinds of information are easily incorporated, and what knowledge and information seems to be excluded (if any)? What are the effects of various forms of ownership on the design, implementation, and availability of systems? What alternative possibilities might exist (alternate logics, new system possibilities, new procedures for incorporating knowledge systems) that would increase interactivity, and what trends (such as the privatization of Cadaster information) might be leading to centralization of functions and systems?

4. What possibilities and limitations are associated with using GIS as a participatory tool for democratic resolution of social and environmental conflicts?

Traditionally GIS has come to represent a top-down, technology-driven approach to social science and decision making. Some have claimed a GIS construction reinforces and legitimizes existing power relations and spatial inequalities within society. How may GIS be constructed so as to democratize and support genuine community involvement and empowerment? Participatory GIS has many potential benefits but also a number of

contradictions. These include differential access to data, capital, and expertise, and the increasingly commoditized/privatized representations of landscape. Can participatory GIS be successfully employed for bottom-up development planning and resource allocation? Furthermore, under what conditions might GIS operationalization be conflictual or consensual?

5. What implications do the results of this research have for the types of ethical and legal restrictions that should be placed on the use of GIS? (Utilizing the results of Initiative 16: Law, Public Policy and Spatial Data Bases)

The rapidity and efficiency with which data can be collected, analyzed, and represented raises a set of ethical and legal questions. First, in which cases does this additional power render obsolete traditional means of thinking about ethical issues, and in which is it irrelevant? In which cases did earlier judgments about whether to make data "freely" available make implicit assumptions about the ease of accessibility of those data, assumptions which no longer hold? Second, to what extent does the use of remotely sensed data create problems with respect to the right of individuals to privacy? Third, to what extent does the possibility of creating data profiles which appear accurately to characterize residents of small areas affect privacy? And, fourth, what are the social and technical possibilities for change? At this point the research teams should be able to make concrete recommendations for overcoming the impediments they encounter. For example, if it were to be found that the process used in the development of national and international standards such as FIPS 173 and ISO 9000 is heavily weighted in favor of government and industry, the research teams should be able to recommend the changes that would be needed to broaden the scope of actual users.

Research into issues 1 through 5 is best undertaken through intensive case study analysis where the inclusion of other voices and the potential for democratization of GIS can be interrogated in particular practical cases; with case selection undertaken in order to gain an understanding of these issues in a range of social and political situations. We have chosen to focus on three specific case studies: the administration of populations in state and business organizations, locational conflict involving minority

populations, and struggles over land and resources. These represent tests of the issues on which the Initiative focuses. They each involve groups that hold, according to conventional wisdom, different 'worldviews.' Each focuses on the question of how and in what ways systems of representation and use can be developed which permit access and appropriate use by groups who are often unsuspecting subjects, several of whom are poor and with limited western style education. In this way, each represents a good case of whether GIS is accessible to non-consenting subjects and disadvantaged populations, and provides important contexts for investigating the need for a culture-sensitive GIS. Finally, each case study represents areas where preliminary work has already begun. We take this to be essential to the successful completion of the Initiative.

Part Two: Research Clusters

I. The Administration of Populations by State and Business Organizations

In recent years a series of political, economic, and technological developments have made it increasingly important to think about the ways in which the logics, systems, and the representational content of contemporary GIS support particular types of social practice and inhibit others. The increasing capacity of GIS to monitor urban commuters, track sectors of the population, or model and target consumers, for example, means that several critical questions about access, privacy, and use must be addressed. The ways in which GIS is deployed in the administration of populations will be investigated in several ways.

Which data? Who decides?

Until very recently, the national and local (in the U. S., the state) have been the primary sites at which GIS have been developed. They have been primarily used for land-use applications, related to zoning, long-term planning, and the like. But the availability of GIS has accelerated the development and deployment of global positioning systems and remote sensing systems, and together the three constitute a powerful means of

systematically tracking a wide range of natural and social phenomena, and in particular of developing monitoring systems for tracking populations. The development of these systems raises a wide range of questions about the types of assumption, data, and representation that are incorporated in any GIS: Who decides which data are to be collected? Who decides how those data are collected, which categories (of race, gender, species, and so on) are to be used? How will the accuracy and validity of those data be measured and guaranteed, not in the technical sense of data-error, but in a political sense of data-appropriateness? And related to these issues, it will be important to investigate issues relating to who exercises control over these data and their representations: How is the trade in those data among agencies regulated (Curry, 1995 forthcoming)? To what extent do local individuals and groups have access to data (Mikhova and Pickles, 1994)? How is the balance between rights to access and rights to privacy currently being struck? Finally, because state agencies are both users and regulators of software, hardware, and data, themselves valued commodities, questions arise concerning the ways in which these agencies adjudicate their sometimes competing responsibilities of protecting its citizens and promoting use (Rossmeissl and Rugg, 1992; Rowley, 1992).

Differential power, scale, and the issue of access: what are the technical and social impediments to wider access to and use of GIS?

If we are to understand better the impediments to GIS access and use, we must investigate the institutional settings within which contemporary GIS have been deployed. We propose to study the ways in which GIS has been incorporated into public and private organizations at different scales (international, national, regional, and local) and to evaluate the effects of institutional context on access and use. In an increasingly internationalized community, and one with an increasing regard for environmental and social problems at a global scale, the availability of geographic information systems can be of tremendous benefit.

At the present time, local systems and locally specific applications of GIS are proliferating. At the same time there are strong pressures (on the part of regulatory

agencies, vendors, or users) for those systems to be combinable and to be combined. In this case, questions of access, privacy, and use emerge as a scale problem. However, the effects of linked processes of centralization and decentralization of development, control, and use are not at all clear. On the one hand, these processes pose important theoretical questions about the ways in which GIS are configured within different social and political systems, different structures of power (for example, central planning or liberal democracy), and different regulatory frameworks and institutions. This is particularly important in the context of the commercial and strategic globalization of information technologies (Roberts and Schein, 1995).   Globalization of GIS is occurring under the aegis of a range of institutions: powerful national governments (such as the U.S.) are working to normalize standards that guarantee the competitive advantage of their own producers and users; non-governmental organizations, like the new World Trade Organization, the World Intellectual Property Organization, and the International Organization for Standardization are emerging as international regulatory agencies; and hardware manufacturers, software developers, providers of data, and business users are competing for a broader range of market share. Each of these institutions has different interests, and in promoting those interests each is likely to promote applications that have different implications at different scales(Curry, 1995; Gutterman, 1992; Haus, 1992; Pickles, 1995).

The very term 'international' suggests that the apparent neutrality and universality of GIS makes them ideally suited for work in this arena. But there are difficult questions involved here. First, the 'international' arena is not a space of equal power and access. As a consequence we need to investigate the implications for organizational access and use of systems developed for uses at different institutional scales (for example, whether systems that are being developed are responsive to the needs of smaller nations or non-governmental organizations). Second, since many applications of GIS are aimed at the administration of populations, often by state bureaucracies or private corporations, it will be important that we investigate the extent to which, and the ways in which, existing geographic information systems are (or are not) tailored to the needs of these clients, and the extent to which they can be used by other groups such as grassroots organizations (Flaherty, 1989). As we have already found in Eastern

Europe, the diffusion of GIS into countries like Bulgaria under the aegis of international programs (such as PHARE) has served to reinforce the existing centralizing tendencies of Central Ministries and weaken grassroots environmental organizations (Mikhova and Pickles, 1994).

Questions of access and privacy need to be contextualized in terms of the scale of application, and evaluated in terms of how, and at the behest of which groups, the systems are to be developed and maintained. The increasing potential for the centralized administration of populations versus the decentralization of GIS technologies and practices to local communities will be investigated in the contexts of newly emerging scales of use, the differential nature of access, and the emerging frameworks and institutions within which use and access are being regulated from the local to the global.

The relationship between private and public developers, vendors, and users of GIS

The emergence of Geodemographic Information Systems (GDIS) as targeted marketing strategies has already pointed to the emergent dangers of the use of GIS to further the commodification of everyday life. In the case of GDIS the issues go beyond the increasing efficiency of marketing agencies to target consumers with particular tastes and purchasing habits. They involve questions about the constitution of identity. GDIS consumer profiles are aggregate profiles based on neighborhood level data from which individual profiles are constructed. The targeting of commercial, political, and public service materials to individuals based on neighborhood derived profiles in turn 'produces' new identities (in that it channels and restricts the information individuals in that neighborhood receive). Thus, even beyond questions of access and privacy, GDIS raises fundamental questions about the ethics of using information systems in ways that presuppose (and in turn contribute to the development of) socially homogeneous neighborhoods (Goss, 1995; forthcoming).

The production and sale of software, hardware, and data across international borders also raises in a new and complex way old issues, in this case issues of intellectual property and data protection (Schier, 1993). At the same time, the commercial

availability of global positioning systems and satellite imagery places the corporation in a position to collect its own data, without regard for borders. If these facts raise the obvious questions, of how to control piracy and of how to regulate trans-border data flows, they raise additional ones: How are people and groups to be represented? In what ways will it be possible to reconcile the representations produced by a GIS with the desire to maintain a sense of individual rights, local autonomy, and cultural integrity? What are the relationships between corporate and public development and use of GIS?

II. Locational Conflicts Involving Minority Populations

There is a basic paradox in using GIS to address issues of locational conflict, one of the principal applications for which GIS has been developed. On the one hand, conflicts over the use of space typically involve competing sets of values, assumptions, and interests. On the other hand, geographic information systems typically assume a universal set of objectifiable and 'self-evident' components of the processes they model (Sheppard, 1995). GIS representations are often based on the assumption that there is a single version of reality to be modeled, and that conflict resolution principally involves the discovery of the most efficient solution to this objectifiable location problem. As a result, the use of GIS in locational conflict resolution has but poorly served the interests of those whose viewpoints and values differ from those incorporated in GIS models.

Not unexpectedly, the representations incorporated in GIS models of urban locational conflicts tend to reflect the views, values, and interests of dominant sectors of society. Ethnic, racial, and sexual minorities whose values and interests differ from those of culturally or economically dominant groups thus may be doubly disadvantaged when locational conflict resolution involves a significant GIS component. Not only are their interests not intrinsic to the models on which technical solutions to complex problems are based, but they may lack access to the tools used by planners and politicians in making their decisions (Miller, 1992; Lake, 1993; Aiken and Michel, 1995).

Many of these issues become clearer when they are examined in the context of specific locational conflicts in North American urban settings. (A broad variety of alternative

settings could be examined, but GIS has been used in city planning departments in the US and Canada perhaps longer than anywhere else, to address a wider range of issues.) This initiative proposes to look closely at several discrete types of urban locational conflicts that have been addressed using GIS approaches.

Efficiency versus equity considerations in GIS: Risk assessment and the location of hazardous materials or facilities

Historically, hazardous materials and facilities have been located in close proximity to the residences and workplaces of the poorest and most marginalized groups in society, in a pattern that some have termed "environmental racism." As Julian Wolpert pointed out in the 1960s, socioeconomic elites typically are better able to organize and marshal resources to ensure that their interests are served first in locational conflicts. While the application of GIS to assess environmental and technological risk has increased rapidly in the last five years, for example in assessing the risk from air toxins, monitoring the quality of ground water, analyzing the response to earthquakes, and wildfire management planning, in most instances the development of a detailed database focusing on the actual risk has not included adequate information on basic geodemographics. Thus even though accounting for impacts on disadvantaged social groups must become an integral component of GIS in the domain of risk analysis, the identification of appropriate subgroups of the population most susceptible to risk is largely absent from both the database and the analysis. The few existing studies have uncovered strong spatial associations between the location of both minority and lower income populations and that of hazardous materials; a condition labeled by some as "environmental racism" although the term implies a planned positioning of environmental hazards that may not always be valid. McMaster (1991), using grid-based GIS analysis and modeling, found strong correlations among minorities (including African-American, Asian, and Hispanic) and hazardous materials sites in Santa Monica, California.   Applying tract-level analyses of 1990 Los Angeles census data, Burke (1993) found associations among Toxic Release Inventory (TRI) sites, lower income groups, and minorities.

When a seemingly value-neutral GIS identifies urban neighborhoods in which hazardous environmental materials are to be located, more marginalized groups typically find themselves at a double disadvantage: their values are rarely the ones on which the GIS has been based, and their ability to dispute the "scientific" claims arrived at through GIS technology are usually outweighed by those of better-off groups. The basic research questions in such cases involve issues of how the competing interests of the less powerful are or can be represented in GIS analyses; and whether and how systems designed primarily to ensure efficiency (through least-cost solutions, for instance) can be made sensitive to issues of social equity and protection of minority positions. Outcomes of research into these issues should include suggestions for achieving greater participation of various social, racial, and ethnic groups in GIS-based assessment studies; inclusion of competing value systems; broader environmental and social justice; and protection of minority interests. An important additional consideration is the differential impact by gender within communities, because of the different ways men and women utilize urban space, and their varying household roles.

Incommensurable value systems and their representation in GIS: Native American treaty rights and land alienation

A related set of issues arise in the use of GIS to revisit claims of Native Americans whose lands were ceded to the government in the nineteenth century, and whose abrogated treaty rights are now a basis for reevaluation of that land alienation process. A basic problem involves the fact that GIS analyses are far better at incorporating certain types of variables than others (Poiker, 1993). Clearly, the variables incorporated in GIS representations are not always tangible: for instance, both physical forest resources and conceptual property boundaries are included in GIS databases used in adjudicating land disputes. However, intangible factors related to competing value systems are not usually present in such analyses. How can factors such as emotional attachments to and the sacredness of place, the role of place in creating and maintaining community, use rights versus property ownership rights, and alternative views of nature be incorporated adequately into the GIS analysis of such conflicts

(Chrisman, 1987; Mark and Frank, 1989)?   If such non-economic calculi are not amenable to incorporation into GIS models, should decisions be based on GIS analysis (Rundstrom, 1995)?

Using GIS in political redistricting

One of the true success stories of early GIS use is in political redistricting, by its very nature a contentious arena. GIS is admirably suited for such a task, since it can take the decision rules used in redistricting and apply them in an objective manner to demographic data to produce a new political map. However, it is precisely in the formulation of the rules by which the GIS redistricting will create its districts that the potential for contention comes. The practical goals for political redistricting are interpreted differently by different actors in the process. Incumbents want to be protected, challengers wish to be aided, minorities desire representation, while majorities want to ensure that their hold on power is at least proportional to their numerical superiority. While GIS use is touted as a more objective and fairer method of political reapportionment than the back room wheeling and dealing it replaces, it isn't clear that different interest groups are given more egalitarian treatment when GIS is used. Specifically, how have GIS solutions to redistricting problems taken into consideration the rights and desires of minorities? Does the technical nature of GIS solutions advantage or disadvantage particular groups in the reapportionment process? Can all groups participate fairly?

GIS and Persons with Disabilities

For people with physical disabilities, navigating the urban environment can be a harrowing experience. Participation in complex activities can be hindered by a single instance of a physical barrier, making careful planning a necessity for many disabled individuals. GIS has been used to assist in this process (Golledge, forthcoming). In this case, GIS is being used proactively, rather than simply as a monitoring or planning tool. The goal of GIS use is to provide greater accessibility by disabled individuals to a

fuller range or activities and services. However, not all barriers to access are physical. Can GIS expand its utility in this instance by incorporating psychological barriers? Economic barriers? Multiple barriers based on the conjunction of disabled status, race, gender, or economic position? To what extent are the affected populations involved in the design of GIS-based strategies for identifying and removing barriers? To what extent are such analyses and solutions the result of the more narrow application of rule-based decision strategies? Is there any incompatibility between the use of GIS in assisting the disabled to navigate through the urban environment, and the use of GIS as a weapon in the fight for greater compliance with the Americans with Disabilities Act? This, of course, raises the larger issue of the dual use of GIS technology in both planning and political activity (Aiken and Michel, 1995).

III.   Natural Resources and Political Ecology

What are the technical, conceptual, and practical problems of dealing with alternate knowledge systems in cross cultural settings? How are particular knowledge systems privileged in existing GIS approaches? How can different types of knowledge and information be included? Can this take place within existing systems, or do new/different system logics, configurations, and practices need to be developed? If the answer seems to be that new/different system logics, configurations, and practices are needed, then what options and needs exist?

> *Bridging regional political ecology and GIS: how can GIS address the ways in which assessments of bio-physical resources are culturally constructed, politically contested, and scale-dependent?*

Political ecology brings together two broad concerns within geography and the social sciences; that of political economy and cultural ecology. The operationalization of regional political ecology follows a chain of explanation which starts with local land managers and land-use practices, while specific social relations of resource use are contextualized in terms of their relations with each other and other land users as well as

the state and global economy (Blaikie and Brookfield, 1987). Regional political ecology thus addresses the politics and social relations of resource use; environmental knowledge production and representation; and the multiple meanings and practices of sustainable development. In its concern with connecting scales of analysis, rather than with the regional scale per se, regional political ecology is well suited to GIS production. GIS, however, imposes a particular conceptualization and logic to the process of inventorying and allocating natural resources. GIS applications in resource management tend to be technology, data and agency driven; technically oriented; capital intensive; and based on digital representations of environmental space. This technicist conceptualization of nature, based on spatial primitives, privileges certain ways of knowing the environment and constructing images of the landscape.

How does, and how can, GIS incorporate multiple realities and competing representations of ecological space?

Conventional GIS approaches to resource management reproduce the production and dissemination of environmental knowledge in the image of existing power relations. This structural distortion of knowledge sets limits on the GIS production process. An important challenge to the GIS community is the incorporation of multiple realities of ecological space. For GIS to be a pluralistic technology which supports democratic decision-making, the technology must be capable of supporting multiple realities and representations of nature. This should involve, for example, both conventional environmental data and information from non-conventional sources. The latter may include behavioral information derived from local community perceptions of ecological space.

How do socially differentiated communities participate in GIS knowledge production, and how is access to the framing and use of GIS to be broadened in such contexts?

To date, a diverse range of theoretically informed case studies have been produced which address the central geographical questions of the social relations and politics of natural resource access and use at different scales of analysis (Katz, 1991; Watts, 1983; Zimmerer, 1991). These have been overwhelmingly impact oriented, with a particular focus on Third World land degradation and social change associated with agrarian transformation (Bebbington, 1993a; Bell and Roberts, 1991; Black, 1990; Blaikie, 1985; Carney, 1993; Moore, 1993; Yapa, 1991; Zimmerer, 1994). Recently, political ecology has also become incorporated into emerging debates on the inadequacies of traditional developmentalism for more equitable and democratic socio-environmental transformation and, more generally, poststructuralist concerns with discourse, power and epistemology (Bebbington, 1993b; Peet and Watts, 1993; Zimmerer, 1993). Post-developmentalism and political ecology share a common concern for the social relations of resource use and representations of nature, the politics of civil society and new social movements, local knowledge, and the struggles for grassroots democracy. In the light of existing power relations, the process of transforming local social, environmental, and political knowledge into GIS data, or GIS knowledge production, represents an important challenge to the GIS community.

Geographic information technologies are embedded within particular political economies which influence access, availability, cost, surveillance capabilities, undemocratic practice and participation in knowledge production and decision making. Financial costs alone usually limit GIS technology to state agencies or large private corporations. Furthermore, the conditions, or preconditions, which regulate access to that information also usually reside with the same agencies. With the continued diffusion of GIS into development planning, the issue of unequal access to data, technology and expertise is likely to reinforce the political and economic status quo and work against more equitable planning decisions. Thus, the free flow of information is essential to a truly democratic implementation of GIS, and access to GIS knowledge

production has important ramifications for the empowerment or disempowerment of specific social groups within communities and their access to specific bio-physical resources (Pickles, 1991; Goss, 1993; Edney, 1991; Obermeyer, 1993).

What would a "pluralistic GIS" (one containing multiple views of resource value, potentially fuzzy and conflicting information) imply for the ways in which GIS can be used in collaborative decision-making? How does this function with "conflicting" collaborators?

The technical process of transforming local environmental knowledge into spatial data poses a number of research questions. The term local knowledge requires very precise definition for it is a gross assumption to assume that there is a homogenous knowledge base. Socially differentiated knowledge may pose even greater problems than resource issues raised by differential access. One of the main planks underlying GIS is its ability to facilitate and support decision-making. This has primarily been based on the notion of one single objective knowledge or 'truth'. With the inclusion of a combination of more than 'one knowledge' it is likely that a GIS database will contain conflicting information and substantive fuzziness. With the inclusion of locationally fuzzy knowledge many issues arise as to how multi-objective goals, based on multiple-criteria, and using spatially imprecise and possibly conflicting data might actually achieve what is assumed to be consensus decision-making. Perhaps one reason why GIS has achieved such astounding 'success' to date in decision-making support roles is that it is based on only one seemingly non-contradictory perception of reality. Collaborative spatial decision-making is a complex issue even among participants with similar worldviews and knowledge. In the absence of this commonality the difficulties are qualitatively greater.

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[2] This proposal arises out of the work of a number of scholars over several years, and includes three distinct research domains. This bibliography is intended to illustrate only some of the key texts and materials consulted in developing this proposal.

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Initiative 19: GIS and Society:
The Social Implications of How People, Space,
and Environment Are Represented in GIS

In early March 1996, a 3-day Specialist Meeting will be held in Minneapolis to further develop a research agenda for a new NCGIA Initiative on GIS and Society. The meeting will be limited to about 35 participants, selected on the basis of position papers reviewed by the steering committee.

The Initiative will focus attention on the social contexts of GIS production and use and address a series of conceptual issues:

1. In what ways have particular logic and visualization techniques, value systems, forms of reasoning, and ways of understanding the world been incorporated into existing GIS techniques, and in what ways have alternative forms of representation been filtered out?

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

3. How can the knowledge, needs, desires, and hopes of marginalized social groups be adequately represented in GIS-based decision-making processes?

4. What possibilities and limitations are associated with using GIS as a participatory tool for more democratic resolution of social and environmental conflicts?

5. What ethical and regulatory issues are raised in the context of GIS and Society research and debate?

These conceptual issues will be addressed in the context of three research themes:

- the administration and control of populations

- location conflict involving disadvantaged populations

- the political ecology of natural resource access and use

Persons wishing to participate in this workshop should submit a position paper of 1,000-1,500 words, summarizing their research interests and how they relate to the concepts and themes outlined above. A brief outline of plans for continued research on the topic should also be included. Submissions must be received by November 30, 1995, and include a short biography (maximum of one page) describing the author's professional experience and interests relevant to research in this area. Submissions should be made by email to the address below using plain ASCII text. Decisions will be made before January 1, 1996. There will be no conference registration fee, and room and board at the conference site will be provided to all participants. We anticipate being able to cover most travel costs for participants.

: SPECIALIST MEETING AGENDA

Saturday, March 2, 1996

5:00	-	Opening Remarks and Plenary Session
6:45	-	Dinner

Sunday, March 3, 1996

8:45	-	Breakfast
9:30	-	Plenary
	-	Small group discussion on Conceptual Issue 1

"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 have alternative forms of representation been filtered out."

11:00	-	Plenary
	-	Small groups report on discussion generated by Conceptual Issue 1
12:45	-	Lunch
2:00	-	Small group discussion on Conceptual Issues 2 and 3
3:45	-	Plenary
	-	Small groups report on discussion generated by Conceptual Issue 2
6:00	-	Dinner

Monday, March 4, 1996

8:00	-	Breakfast
9:00	-	Plenary
	-	Small group discussion on topic of interest

GIS 2 / Virtual Geographies

GIS as Social Practice / Intellectual History of GIS

Environmental Justice / Political Ecology

Local Knowledge / Multiple Realities / Community Action

Data Access / Privacy / Geodemographics

Gender / Representation

12:00	-	Lunch
2:00	-	Small groups report on discussion topics
4:00	-	Optional time for small groups to continue discussions
6:00	-	Dinner

Tuesday, March 5, 1996

8:00	-	Breakfast
9:00	-	Final Plenary
	-	Research directions
	-	Closing
12:00	-	Lunch

Just Passing Through: Virtual Tourism, Justice and "Informatics"

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An Internet Home Page for Catalina Island, California enables interested participants to navigate through detailed and tangential information and images representing the island's cultural history, natural resources, recreational attractions and a developing GIS. The implications of joining GIS and tourism on the Internet are complex.   It is possible now to virtually tour Catalina Island without leaving home. Will this virtual experience replace first-hand knowledge?   Perhaps, instead, the images will entice more tourists to Catalina Island.   Could the Internet be used to educate and help protect natural resources? Could this be considered a new form of conservation? The problem with questions like these is that they do not deal with the fiction that is, and always has been, Catalina Island. A different story emerges when we consider that GIS and virtual tourism may be used to perpetuate a form of place control that began on Catalina Island over one hundred years ago. What the tourist images of Catalina Island mask is an implicit control of space described in an interesting dance of contrast and contradictions between aesthetics and politics.

Changes in resource access and land-use on Catalina Island over the last one hundred years suggests a political ecology which can be interpreted through tourist images, and the most recent gambit in this ongoing demarcation and control of territory is an interactive GIS. The idea of creating virtual tourism is a second important aspect of the Catalina Island Home Page. With this research project, we speculate upon how GIS is used to define natural resources, conservation, and access in the creation of a tourist place. We draw on studies about the creation of postmodern landscapes (Urry 1990), tourism as imperialism (Smith 1989), the development of ecotourism and the creation of "nature" (Whelan 1991), and our own past work on GIS, representation and policy making (Aitken and Rushton 1993; Aitken and Michel 1994). Our intent is to link ideas on tourism, nature, visual aesthetics and the control of images with the policy implications of interactive GIS for tourist destinations such as Catalina Island.

By tracing the political control of representations on Catalina Island and how this relates to land use and development decisions, it is clear that the GIS can maintain precisely the normative ideas on conservation and preservation that Wrigley established when he bought the island in 1919. William Wrigley Jr. of Wrigley's chewing gum, purchased the island site unseen and is attributed with the remark "My goodness, I thought it was flat" when he first sailed into Avalon Harbor. Wrigley proceeded to create a Catalina that matched his vision and his empire, by literally and figuratively molding the landscape into a shape that he could control. The Santa Catalina Island Conservancy continues many aspects of Wrigley's mission. It

seems to us that GIS technology is enabling the creation of information and landscapes which conform to certain ideas of how nature is constituted and how tourists and residents, insiders and outsiders, wealthy and poor should relate to nature.

Some of our earlier work noted the complexity within which policy decisions are made, and how GIS technology can contextualise those decisions (Aitken and Rushton 1993). Left unconsidered in that work was the power of representation and modes of visualisation in actually creating places. As John Pickles (1995, 9) points out, the emergence of spatial digital data, computer graphic representations, and virtual reality creates an intertextuality that directs attention to the multiple fragments, multiple views, and layers that are assembled under new laws of ordering and re-ordering. Pickles looks forward to the development of a global village on Internet which supports both the access to information and a format for dialogue so that counter-hegemonic social action is encouraged. Our analysis of the images of Catalina Island and the development of the Conservancy's GIS suggest that the exact opposite could happen. It seems that GIS technology, with its propensity for cyborg (Haraway 1991) and Archimedian (Gregory 1994) views, might enable a particular form of imperialism to be perpetuated whereby the "real" tourist experience is available only for those who can afford it while everyone else (including residents of Catalina Island) must make do with virtual tourism.

As part of this research, we analyzed images and maps of Catalina Island over the last one hundred years. We became involved with the Catalina Conservancy to discuss the possibility of creating new tourist maps and a GIS that incorporated a ground-based insider's view (such as 3-D hiking maps). During this process we realized that a certain image of tourist and 'nature' was conflated with a need, by the Conservancy, to create the 'real' Catalina Island. The mission of the Conservancy is, after all, "... to preserve and restore Catalina to its natural state" (Conservancy Times 1994).

At the same time we were exploring the possibilities of virtual tourism with the Conservancy, the first GIS related map appeared as part of an advertisement for Jeep eco-tours of the island. The images in the advertisement (produced on pulp paper) together form a juxtaposition of the Conservancy map, the notion of ecotourism, and a Jeep cruising through nature. Apparently, behind locked gates lies "an island paradise ...isolated coves and pristine beaches" that are made accessible to anyone who can afford $795 per day. A "naturalist-trained" driver safely transports you to places off the map (hidden behind a password on the GIS?).

Thus far, our project is an analysis of past tourist images of Catalina Island using postmodern and socio-semiotic theory that notes how the developing GIS systems seem to justify the old (imperial) social practices in new ways (cf. Pickles 1995). The project continues with a consideration of how social and spatial justice may change with the development of what Pickles calls "informatics." We are not optimistic that a global information system constituted in the form of the Catalina Island Home Page enables any form of contestation which can produce "counterhegemonic social action." If anything, the Catalina Island example suggests that old imperial codes are patched up and presented in more palatable forms. As we

noted in earlier work, if contestation is important within GIS and policy-making, then we must move away from consensus building models such as Jurgen Habermas's theory of communicative action (Aitken and Michel 1994). What we feel needs to be considered more fully in order to realize Pickles' optimism is a model of justice which accommodates difference with new ideas of how community is constituted. We see some possibilities in Iris Marion Young's (1990) ideas of difference and justice because they make explicit the need for contestation between the public and the private, and through spatial scales.

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Initiative on GIS and Society

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Ultimately, GIS is merely a tool to be used in a variety of contexts, applicable to content appropriate to many different issues and as a resource for decision makers who use the tool as an adjunct to their work. GIS has been used to date primarily by persons who value maps more than data and applications. Community leadership and local organizations tend to view GIS as automated mapping rather than as a data organization resource. Information has been often limited in scale to levels at which information is broadly available - rarely to degrees of detail important to neighborhoods. The information generally available is derived from MIS systems or broadly general census surveys - quickly recognized by those addressing community problems as of limited value to the questions that they face.

For nearly four years, Milwaukee Associates in Urban Development, an association of 240 nonprofit organizations in Milwaukee Wisconsin, has operated a Neighborhood Data Center program. This program has become a comprehensive GIS service operation. Block, parcel and accurate address map bases have been created or adapted. Data sets from a wide variety of sources have been negotiated for, cleaned up and integrated with each other. More than 100 local, neighborhood based organizations have been served by short term products tailored to specific neighborhoods and to specific program content issues. Templates have been developed to streamline the creation of data tables and maps so that production efforts can become secondary to new applications.

The most important aspect of the Neighborhood Data Center program has been its development within an organization with a clear mission to support the "empowerment" of local organizations to expand their capacity to work with data. Community development objectives have been realized in a number of ways: A substantial series of educational sessions have been offered to identify the vision, to help organizations to identify needs and to interpret available material and to use more sophisticated tools. Focus groups within specific content areas - housing development, health care, services to the elderly, youth programs, block club development, crime prevention programs, and others - have informed priorities for data development and created a collaborative environment for further data acquisition and research. A "community fellows" program has provided up to 100 hours of training for selected community organization staff. A group purchase of a GIS program included training and support of 8 nonprofit organizations in ongoing use within their organization. Recent collaborative neighborhood planning initiatives have increased the demand for a broad range of information and for improved methods of communicating patterns to residents. A "fee for service" model required that the program aggressively

market its services and demonstrate cost effective value to financially strapped nonprofit organizations. Collaborative projects have involved supporting the value added role of local organizations given the "starting point" provided by public data sets. (Some of these efforts have demonstrated only partial success to date.)

An important outcome of the experience of the Neighborhood Data Center program has been the opportunity to critique the potential and the limitations of existing public data systems as resources for neighborhood organizations. Rarely do existing data sets provide insights neighborhood leadership do not already understand. Frequently, data sets are considerably richer when reviewed, corrected and enhanced by neighborhood organizations. As data systems improve, the capacity of such systems of data to inform and shape models of change within neighborhoods increase. Political and practical barriers to achieving relevant data systems can be substantial. But Milwaukee has reached a point that enough good information is available to demonstrate the synergy of comprehensive data systems and the value of GIS techniques to manage this information.

There are implications of these systems for new levels of neighborhood research as well. Annual data on individual properties, housing sales, crime events and other data allow micro level analysis of neighborhood change that permit serious investigation of the sequence of events that contribute to neighborhood decline. In Milwwaukee, the best of these data sets are available for 21 years.

Both neighborhood program planners and researchers working to reassess our understanding of community issues are able to articulate needs for information that should drive future efforts to expand public data systems. While it is easier to "demonstrate" the power of GIS by performing exercises which "fit" the data that is most available, it is important to ask the question - What data is needed? This can be embarrassing because future users of data often ask for data that is not available and may be very difficult to access.

Data needs are also informed by the paradigms that users bring to the table. Data frequently focuses upon deficiencies and problem indicators rather than addressing assets and achievements. Public data sources may be more effective at identifying the problems individuals face rather than the failures of institutions that are important elements in the problems communities identify. Private organization information is even more difficult to access and analyze. (A major home insurance redlining case in Milwaukee demonstrated what could be done with court leveraged access to such data.)

Community development models are often premised upon the assumption that neighborhood organizations and leadership should not merely have access to data services, but that they should gain the capacity to do data analysis themselves. Does this mean replacing the role of technical assistance professionals? Is the context for GIS as a data manipulation environment too complicated to trust to those with limited training, even as the basic interfaces become trivial? Are local organizations likely to develop an organizational culture that embraces serious investment in data analysis and decision support systems informed by data? It is likely that new models will call for greater levels of collaboration between

professional organization with access to more complicated data sets and analysis tools and the local consumers of data who can also improve upon the content of data sets and contribute "stories" (case studies) that also provide insight into what is going on.

To the rest of the hype about the "Information Highway" it is appropriate to add the potential of the Internet as a vehicle for access to data and maps, distributed processing, and greater collaboration among local institutions and between organizations with similar agendas in different communities. Our insights into more effective models for data analysis will be more easily disseminated in this environment.

Grassroots GIS in the Southern Appalachian BioRegion

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The Southern Appalachian Forest Coalition consists of a core staff representing and coordinating the efforts of national and grassroots environmental organizations throughout the Southern Appalachian Bioregion. SAFC is devoted to the development and implementationof a common vision for protection of the native biodiversity of the Southern Appalachians. Brooks is allied with SAFC consultant in GIS and planning.

Our goals resonate with Initiative 19s conceptual issue four, which reads:

> What possibilities and limitations are associated with using GIS as a participatory
> tool for more democratic resolution of social and environmental conflicts?

In terms of Initiative 19 research themes, there is no doubt that we are concerned with the political ecology of natural resource access and use -- Our GIS efforts aim to influence the disposition and exploitation of public and private lands across the entire southern Appalachian bioregion.

Below, we highlight our issues relating to participatory use of GIS in the context of natural resource conservation.

Action Goals

- Access to Federal (US Forest Service and others) spatial datasets in a timely and effective manner;

- Develop alternative, locally based spatial data by grassroots organizations;

- Develop alternative interpretations of Federal datasets by grassroots organizations;

- Pinpoint inadequacies and false assumptions in Federal datasets and analyses;

- Propose alternative datasets and techniques addressing these inadequacies;

- Distribute 'raw' and 'enhanced' Federal data amongst local groups, and share locally developed data amongst member groups;

- Use these datasets in a GIS environment to propose and affect USFS and local land planing and allocation. (As put so well by Denis Wood, we make our own maps);

- Meet Federal GIS activities head-on; Match or exceed Federal analytic and technical GIS capabilities;

Issues and Impediments We Face

- Limitations to free and easy data exchange and distribution. What method is least burdensome in technological and financial terms?

- How can SAFC facilitate local GIS expertise? We seek the most effective and empowering way to assist local groups to develop self-reliant, expert GIS capabilities;

- Even with technical parity, how do we physically and politically integrate our spatial proposals into National Forest (and other) planning processes?

So Far We Have

- Established a viable organization in SAFC, with foundation backing;

- Developed core membership, allies and assembled needed expertise;

- We were the major 'public' participant in the now-concluding Southern Appalachian Assessment. We influenced its direction, process, and GIS data development and analysis in major, positive ways. We will now use and supplement the SAA datasets (5 CD-ROMS) to advantage;

- We developed a prototype Conservation Plan for the Chattooga River Watershed, working for and with the Chattooga River Watershed Coalition;

- We now extend this methodology to the Black Mountains, and soon to all areas of the SAA;

- We begin development of methods to address the issues we noted, including outreach, partnerships, and prototype, 'glass-box' GIS land planning system;

We Plan Also to

- Engage in further training, outreach, software development and data development as needed and desired by our partners;

- Work with our partners to assemble a Bioregional Conservation Plan, evolved from the grassroots -up to the region, and back; We relate micro-meso-micro scales;

- Use GIS in a participatory and political manner to achieve the grassroots agenda;

- Continue to interact with and counter the Federal activities in the Bioregion;

Discussion

Although environmental groups are typically not members of the urban underclass, they are in many ways excluded from current technological developments like GIS. Age or personal predilection have excluded them from such participation. The playing field has evolved, though, and now includes this technology. With the USFS 615 program and other Federal GIS investments, there is a total strategic necessity to understand and employ GIS;

We know the enemy (Sun Tsu), and although the enemy may also to a certain extent know us, the enemy in this case is required to provide for us their data; As long as we can read and understand it, we have the advantage; We may provide them data as we see fit.

The importance of grassroots activity like ours was underscored in a recent Clemson University lecture by Leo Marx (MIT emeritus professor; author of Machine in the Garden). He reiterated the postmodern domination and abstraction of nature and space by the modern mega-organization. Wise GIS use by the grassroots is truly the only way in which GIS and space will not be dictated and dominated totally by these forces;

We seek to work with and ally ourselves with like minds to mutually evolve solutions to our needs. Our solutions are likely to be others' solutions.

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Research regarding Geographic Information System (GIS) has mostly established possible technical solutions. In the era of novelty, this strategy was really the only one, since the technology had to be invented. More recently, some of the aspects of GIS development have been criticized from the perspective of social theory. Curiously, both the original proponents and the critics seem to accept a view of GIS technology as autonomous, for opposite reasons. The proponents wish to create new solutions as a free act of imagination, then somehow expect them to be implemented because they are technically superior, not for more complex reasons. These proponents do not wish to have their motivations questioned and reexamined. The critics also seek to ascribe features to 'GIS' as a whole, lumping the technology into some mechanical unity. It is odd that these two groups both place the technology in isolation from its social context. Yes, the critics will talk archly about social context, but the technology itself is still demonized as if an inhuman construction, foisted on hapless society. Nothing is further from the case. In some sense, society gets exactly the technology it deserves, because the society is responsible for what it creates.

In order to establish a viable research strategy for the linkages between GIS and society, it is important to accept three principles that are not clearly articulated in the call for participation in I19:

1) Social context influences GIS, and GIS influences society.

2) Multiple social structures interact in this process.

3) GIS technology cannot be reduced to some mechanicistically determined parts, the people act as agents.

Research must of course focus its attention to be effective, but any project that identifies just one direction of influence blinds itself to the whole process that produces and reproduces GIS in its web of social interactions. Similarly, social theories must focus on specific components in this large web, but they risk losing sight of the whole context. These issues are difficult to address without understanding the last one concerning technological determinism.

On the question of the direction of influence, it is clear that few hold to the neutrality of GIS. The GIS proponent hopes that the new systems will influence social goals in some direct intentional way. The critics of GIS, at least the most outspoken, have taken on a horror of the changes produced. Yet both of these groups have very little evidence of the actual result of the change in mapping technology. There have been some rudimentary economic studies, but very few studies that address the social outcomes. For example, despite millions of dollars spent on tax records, there have been few studies of the equity of the results. While we can postulate that social forces hold the potential of GIS in check, there is little in the way of direct documentation. These two aspects would be the two directions of influence. In order to convince, I believe that we need well-designed research using historical reconstructions, case studies, ethnography, participant observation, and other social science methods.

In my estimation, the role of disciplines, professions and guilds provide an inescapable component of the social relationships that influence the ways that knowledge is structured and represented in a GIS. The nature of disciplinary and scientific development must be addressed to be able to understand how GISs end up as they are. Certainly no scientific enterprise is isolated from the overall social and cultural environment, but each discipline develops its boundaries and its way of viewing the world. This division has had an impact on the development of GIS inside North America and Europe, the hearth of current technology. Simply positing a society with the 'disadvantaged' versus some unitary 'state' oversimplifies the circumstances so far as to exclude the majority of social interactions involved in a GIS.

The practice of many guilds and disciplines (including surveyors, highway engineers, soils scientists, foresters, property appraisers, planners, petroleum geologists, ecologists and more) involves representing the Earth's surface. These groups are trained in remarkably different ways. Some are trained strictly on the job - embedded in a particular context, while others require long theoretical and scientific training. These shared experiences of training create the shared meanings of quite identifiable subcultures. These groups are often quite isolated from each other, socially and culturally. You only have to attend the Annual Convention of the American Congress on Surveying and Mapping to see how different the cultures of surveying and cartography can be. And, the coming of GIS has required these different subcultures to mix in new ways. The old structures of authority have been broken and new structures are emerging. It is very important to start this research before the older ways of thinking have become totally swept away.

Research on society and GIS must also examine the contingency of GIS activity, particularly the role of individual agency within the structure of relationships imposed by history, society and culture. I think that such research must focus directly on the practice of GIS inside complex organizations. The organizing theory must deal with multi-disciplinary ways of knowing, as implemented in competing GIS representations. The reproduction of these views of society should become a subject of research, not simply assumed using a black box model of technology.

As one example, my recent research on the social practice of GIS has drawn closer to the literature on the sociology of science. The emergence of a 'bandwagon' in science requires a bit more than the simple

'paradigm' model of Kuhn. Multiple social realities interact in this process, which I connect to key elements in the development of GIS. I find Fujimura's constructs of 'standardized packages' and 'boundary objects' (see chapter in the 1992 book titled Science as Social Practice) particularly helpful. I have chosen to illustrate my research using a case study of the siting studies performed in 16 states for low level radioactive waste storage. While one element of this process does deal with the disadvantaged elements of society, that issue is far from the center of attention. The main divisions fall across disciplinary boundaries within science and the institutions involved in these projects. Though at an early stage, I am confident that these low-level waste projects will illustrate how the practice of GIS is socially contingent. By adopting a focus on sixteen project to implement the same federal regulation, I am trying to employ some experimental design techniques to explore the local contingencies within a framework that limits the diversity to just certain elements. This kind of attention to experimental design will be crucial to avoid fooling ourselves. I think my LLRW study addresses the basic intent of the initiative more directly than an attempt to go make a single attempt to design a GIS for the disadvantaged in some corner of the agrarian third world. I am quite hesitant to engage in more research in the mode of 'demonstration project'.

Research on the social aspects of GIS cannot avoid the 'technical' details of a GIS implementation. I expect to find the clearest traces of different disciplines in the specific tools in which they are trained. The engineer designs databases around positional accuracy, just as the accountant seeks the audit trail. These are their heritage and their way of organizing the world. In the case of LLRW, there are nuclear engineers trained in the particular methods used to locate nuclear power plants in the early era of environmental impact statements. Their belief in a rational model for decision making traces back to the operations research heritage of the Manhattan Project. Their heritage crossed paths with the movement for environmental planning, the background of McHarg whose simple approach to map overlay helped create the conceptual framework for GIS. These heritages have been passed on through training and through social authority structures. Eventually, the details of these subcultures come to influence the larger culture. Of course, none of these connections are deterministic. Each subculture absorbs concepts from their surroundings and becomes fundamentally changed. The individuals in these groups also live in other roles, thus mixing the connections.

I suggest that this initiative be given the simpler title of 'GIS as Social Practice'. It should focus on the tension between society and technology, giving equal weight to the historical forces and the possibilities for creating new arrangements.

Future Research Statement

As articulated in the Position Paper, I plan to continue to design research projects to study the social practice of GIS. The Low-Level Radioactive Waste siting projects were selected because some of these projects involved massive GIS work, while others slapped together an answer on a much smaller budget. The differences in the GIS operations seem to provide access to the connections between GIS and culture. If the LLRW projects do not provide the most convincing demonstrations, I will look for other 'natural experiments', comparative studies that situate the cases in their historical and cultural context. I have done demonstration projects and I have intervened to design software and institutions. I think my research should step back a bit from that direct role.

I have held an interest in the 'Geography of Geographic Information' for a number of years. It has taken some time to articulate what this will involve (the art is long...), but the variation in the practice of GIS seem to link to some critical differences in the organization of societies. Geographic information provides a useful indicator of some of the key questions in human geography.

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In their book entitled The Unreality Industry, Mitroff and Bennis (1989) define two kinds of unreality: Unreality One or Artificial Reality makes the unreal look so real that we cannot tell the difference between the two. Unreality Two or Pseudo Reality, on the other hand, makes the unreal so attractive that we no longer care about reality. The authors aim their critique primarily at TV news which, in their view, have turned current events into just another form of entertainment. I was struck by some strong parallels between the representation of current events on TV, as viewed by Mitroff and Bennis, and the representation of the geographic world in GIS, as discussed in this workshop. While the goals of the two enterprises are clearly very different (luring audiences through entertainment, versus winning professional markets through increased efficiency and productivity), both the means (electronic manipulation of facts and images) and the results (production of unreality of both the first and second kind) have strong similarities. This is not to denigrate an immensely useful technology, but rather to better understand it in the context of the information society of which it is part. Such understanding is all the more critical in view of a third kind of unreality the information society is generating - let's call it Unreality Three, or Geographic Unreality. Together, the three unrealities suggest a research agenda that this workshop may wish to take up.

No one will deny the close relationship between television and computers (especially the desktop kind): as physical objects, as electronic technologies, as visual representation devices, as icons of the information age. It is hard to imagine a society falling in love with desktop computers that was not already in love with its TV sets. The world in a box in two formats: as the six-o'-clock news on your kitchen counter, as the pulsating Netscape logo in your office/bedroom. The world in a box, more literally still, as the layers in your ARC/Info.

Mitroff and Bennis (1989, p. 40-51) spell out the mechanisms of unreality production in the media. Among them are: boundary warping, or the distortion and confusion of boundaries between realms of reality (between fact and entertainment, between actual and possible, between past, present and future); image engineering; the disconnectedness of ideas ("no connective thread, overall context, or historical perspective is provided..."); a self-sealing universe, referring "less and less to anything outside of their own artificially self-constructed self-contained world"; radical simplification; reverse causality; the decentralized industrial stage of unreality production; and infrastructure penetration. It is rather trivial to argue that these

characteristics also apply to the geographic world as represented in GIS. More subtle is the relation of GIS to some other unreality production mechanisms on Mitroff and Bennis' list, which at first sight do not seem to apply to apersonal information systems: personality fragmentation or splitting of the person (faces, other body parts, or moods and emotions are treated out of the larger context of the person); person engineering (personalities may be packaged to fit any popular stereotype); and personality reduction (abstract ideas tend only to exist if embodied in a concrete person). But try to substitute "geographic concept" for "person" - think of the standard data structures and operations, the display conventions, the reified polygons and layers, the language of objects and fields - and the pattern is once again recognizable.

Analogies, however instructive, should not be pushed too far. The point here is that GIS, like television, is much more than just a means to access information about the world. The immediacy and sensory concreteness of the visual electronic media have cognitive, emotional, behavioral, and social effects far beyond the factual knowledge conveyed by the data or facts underlying the representations (Meyrowitz, 1985; Couclelis, 1994). Just as television (unlike the newspaper) blurs spatio-temporal distinctions and substitutes the illusion of direct experience for the narrative ("once upon a time, once upon a place..."), GIS (unlike the map or the text) lets you see and explore the world without the hassle of the trip, the field work, the regional study, the voyage of discovery. Come on, kids, let's have GIS show you your neighborhood! Look through this screen, politicians, and see where your worst problem lie!

Reasonable people will always know the difference between map and territory, even as the territory begins to look increasingly like the map. But even if Unreality One (not being able to tell the difference) can be avoided, reasonable people may be forgiven if they find Unreality Two (not caring about the difference) too comfortable at times. On both counts it may be argued (but that would be another paper) that GIS through its images, and what can be done with them, creates beliefs (mythologies, some would say) and molds habits of mind in thinking about the world unlike any that would exist without it. Many others have commented on the dangers of reducing the geographic to the measurable and the visual (Gregory, 1984), and of the silent, invisible, or abstract geographies that may fall by the wayside. Of more concern here is the converse issue of the unreal worlds thus produced - colorful, classified, complete, obvious, remarkably uniform worlds in appearance and behavior, and yours to change at a keystroke.

Put this in the context of Unreality Three, Geographic Unreality, or the budding virtual geographies of places, communities, and interactions taking shape along telephone and fax lines and especially the Internet. In a striking example of life mimicking art, cyberspaces, cyberplaces, and cybercitizens have popped out of the pages of science fiction and into the mainstream of economic and social life. The public interest in this phenomenon is phenomenal, as the myriad of related media discussions, publications, and conference announcements suggest. The terms cyberspace and cyberplace themselves, along with the widespread claims regarding the demise of distance in the information age, constitute open challenges to geography. Yet GIS, "geography's piece of the information revolution" (Goodchild_), has so far had nothing to say on these virtual geographies forming around us. Indeed, its solid grounding in geocoded

information as the fundamental building block appears to preclude the study of spaces, places and events that are not so rooted. Thus we have the paradox of a technology that endows the material world with a host of virtual properties (as in Unrealities One and Two), while the "real" virtual world (Unreality Three), the properties of which are already having widespread impacts on the material world, still escapes it.

These thoughts suggest a number of questions that may be addressed as part of a research agenda for GIS in the context of the information society:

>1. To what extent is GIS used (in education, management, administration, research, etc.) as a substitute for, rather than as a complement or enhancement to, other, more direct experiences of the geographic world? What is lost through that substitution, what is gained?

>2. What differences are there in geographic understanding, in spatial reasoning, decision making, and problem solving, in how geographic phenomena and problems are perceived, in judgments as to what kinds of issues are most important, between those who have been taught geography with a heavy emphasis on GIS, compared with those who had a more traditional geographic education?

>3. How can GIS help integrate the virtual geographies with the actual geographies of the information society? How can it keep realities and unrealities from fusing together (or should it?...).

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Community Groups Need Equal Footing

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There is hope for urban America, but only if we are willing to give more power to the people with the biggest stake in its success: neighborhood and community groups. Information can provide that power and information can be derived from data and GIS technology. The problem is that community groups don't have access to any of these resources. Information providers have sprung up as middle-men across the country, but they are finding the problem runs deeper: community groups do not desire information, they desire responses to immediate problems. Significant work is required both to get better information to these groups and to help groups take better advantage of this information.

Community groups are a critical part of American democracy. They provide a conduit between individual citizens and the external bodies that administer and control them. The conduit passes information between the two bodies, but too often operates inefficiently because the information is incomplete. Several years ago I contacted 31 major cities in North America to learn what current neighborhood-level data is distributed to citizens. The results were appalling, at least in the U.S. where the Census is taken only once per decade. Only crime and health data were regularly available. Total housing unit counts were available annually in a majority of cities. Most population, housing, and economic data were never summarized and distributed for subcity levels between vensus years--despite the fact that most of the raw data for such summaries exists as part of normal municipal operations.

Even census data is becoming less accessible to community groups as the Bureau looks to reduce expenditures. Recent announcements from the Census Bureau indicate that many useful reports will no longer be published, henceforth available in machine-readable form only. Neighborhood summaries will be published no more with the demise of the UDAP (User Defined Area Program); the rationale is that programmers can quickly build their own summaries from block and block-group data. All of these moves assume that all potential users of census data have high levels of technical expertise. This is certainly not the case with community groups, especially those serving low income areas.

In a growing number of places around the country the need for technical assistance is being provided by intermediaries. If an information revolution isto come, these are the quartermasters. They are a ragtag collection of academics, nonprofit groups, public libraries, and government offices. They are taking advantage of more readily available data and technology to supply the troops with the information needed to develop local programs and get the resources necessary for community vitality. Typically these groups collect and process data from the Census, local government, and agency records. Because all problems

are local in nature, they often work with small area data or geocoded records of individual events. These data must be summarized, mapped, analyzed to show the rates within various distances, etc. All of these activities use GIS technology.

To learn more about these groups, I convened a day-long special session at the URISA 1994 conference where eleven premier data providers discussed their successes and frustrations. The successes were significant enough to convince anyone that providing information to community groups is a worthwhile activity. A bilingual Head Start program was located in an area with a concentration of Puerto Rican residents in Milwaukee, a large grant helped a neighborhood group restore a local theater in Pittsburgh, and so on.

Each frustration identified at this session is a potential area for new development and research. One obvious shortfall is the lack of information providers. The NCGIA is revising its GIS curriculum. One of the most useful GIS courses offered at the University of Minnesota--useful to both students and the community--requires students to tackle real world problems. We solicit projects from the community, assign one as a group project while the students learn the potential of the technology, then offer the other submissions as options from which the students can choose their required individual project. Students from this class have gone on to work as volunteers and paid workers with community groups across the state, so this training can provide a long-term solution by upgrading the capability of community groups to access and analyze data to their own ends.

A second frustration is lack of interest in data on the part of community groups. Crime might an important issue and the neighborhood organization would like it stopped, but they don't think about asking for a map of crime incidents--much less a map showing buildings owned by absentee landlords. On the other hand, the appetite for data is enormous. Everybody wants all the data he or she can get. Obviously, these groups are lacking in knowledge and sophistication about what data is relevant. The existing solution is for the data providers to work with individual groups, providing direct answers to initially stated needs, but suggesting further exploration and analysis. This is time-consuming and works only for those community groups with enough interestto visit a data provider. A more efficient solution is to create a "reverse directory" of data and analyses, something that shows what products might be relevant to particular community problems. A second approach is to share solutions among community groups. This approach is used by the Community Information Exchange, a national group based in Washington DC, but their list of experiences is limited. A better approach might build on local experiences, shared electronically, perhaps over local FreeNet. Such an effort is underway in the Twin Cities. The biggest problem with this approach is finding a way to entice those who have developed data-based solutions to take the time to document their experience.

The third frustration is getting useful data from organizations. NCGIA Initiative 9, Sharing Geographic Information, addressed this issue and I was pleased to be a part of that effort. Thankfully the federal government is moving toward putting information on web servers and a number of state and local

government agencies are doing the same. This is good and it would be a valuable research project to see what factors and actors are pushing this development. For example, did neighborhood activists in city X push the city council to instruct city departments to publish data this way or did the initiative come from city staff. The problem with web-published data is that it predefines what type of analysis is possible. Better that community groups are able work with analysts as they choose the data and analytical techniques. No matter how well-meaning the analysts are, they will never understand the issues and concerns as well as the people who must live with them. For this reason, I am frustrated by the wording of I-19's third conceptual issue: "3) how the knowledge and needs of marginal social groups can be incorporated into GIS-based decision-making." The only correct answer is to give them equal footing and have them at the table.

The fourth frustration is knowing how to best use the results of the analysis. At the day-long session the providers said that community groups know how to do this, but I'm less sanguine. One answer given is that community groups often hold a newsworthy event, get their analysis published (or broadcast), then rely on that publication as substantiation of the merits of their case. Another approach is to feed the findings to a sympathetic policy-maker. This approach assumes that the community group is trusted by that person in power. In one case a data provider in Atlanta determined that a state law regarding enterprise zones, written to assist rural counties, would apply to poor urban tracts if only the county geographic limitation were relaxed. A sympathetic legislator agreed to help, but needed the data provider to find other qualifying urban tracts around the state to win support from enough legislators to alter the law. A third approach is to use superior information about your own community to buy access to key management and policy people; a Minneapolis neighborhood mapped crime data and shared the results with precinct officers. Such intriguing stories beg the question. We know too little about how information affects policy and what steps to recommend to community groups.

It is unfortunate that these issues are of such little concern to the GIS community and I am pleased that this NCGIA initiative is underway. As evidence of the lack of interest, an abstract about this topic submitted to the GIS/LIS'95 conference was rejected (but accepted as a keynote presentation at AGI'95). None of three recent proposals by data providers to URISA for its Exemplary Systems in Government (ESIG) Award won anything but honorable mention.

I have described numerous research opportunities. My particular interests lie in the reverse data directory and further study of how geographic information is used to affect policy.

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I. Introduction

Among the most important consequences of the development of geographic information systems is the widespread ability of those in government and business, as well as the public more broadly, to create spatial representations. These increasingly may use three or even four dimensions, and may include a wide range of information about points, lines, or areas. And one consequence of the ability to create these representations, especially in the contrast of increasingly vocal demands for a "right to know," is the development of new threats to the privacy of individuals and groups.

In one sense any computerized information system creates such threats, just to the extent that it makes it easier to obtain information; suddenly, one can with a click retrieve information associated with some parcel or area. Where previously one had to dig through masses of paper, during business hours, in a central location, and under the watchful eye of a suspicious bureaucrat, one can now satisfy one's curiosity about neighbors, employers, and potential friends much more easily. In fact, the increasing availability of such information on the Internet makes it possible to snoop in the comforts of one's own home.

But beyond those problems raised by information systems in general, geographic information systems raise an additional, and rather different set of problems. This is a set that have received less direct attention than the first. These problems arise not from the ability of a user to acquire information already in the systems, but rather from the ability, using the systems, to construct new sets of visual representations. The problems arise where the systems allow the creation of representations that appear to be accurate, but are in the end misleading, or where they allow the creation of representations that are accurate, but that are accurate representations of information that has previously been and ought to remain privileged.

Geographic information systems in this way raise a set of issues that have both ethical and legal moments. They are issues concerning the ways in which one ought and ought not to use these representations; they are at the same time issues concerning the ways in which the use and misuse of these representations ought to be regulated through the legal system.

These issues arise in a number of arenas. Perhaps most obvious is the area of medical data. There the easy availability of data on stigmatized diseases or, potentially, on genetic propensity to disease creates

the possibility for misuses damaging to individual and neighborhood alike. Here the issues raised some twenty years ago, in the case of mortgage redlining, have arisen with a new intensity, as a result of the ease and simplicity of analysis and representation brought on by technological change.

Similarly, the recent development, especially in the private sector, of systems of geodemographics has made it increasingly easy to produce systems of data profiles, ones that represent individuals and neighborhoods as having certain social, cultural, ethnic, and economic characteristics. These geodemographic systems are now widely used in the making of decisions about insurance, lending, and the like, and it seems clear that their use will continue to increase.

My paper today is in the form of a proposal for a collaborative research project. This project is an attempt to make sense of the issues posed by these spatio-visual representations. It will examine current practices in the use of the representations. It will analyze the ethical issues involved in their creation and use. It will then analyze the current regulatory framework in which they operate. Finally, it will suggest ways in which this framework can be improved, so that the right to privacy and the right to know are better balanced.

II. Questions for Research

A. Current Practice

Current practice with respect to spatio-visual representations can perhaps best be seen as growing out of the intersection of three roots. First are a very general set of common-sense principles and practices associated with what might be termed "cartographic ethics." In this category are included the homilies and exhortations that are taught to those learning to produce or read maps—one needs to use due diligence, to be accurate, to be careful in generalizing, and so on. This set of ideas, once relatively untheorized, has lately come to be seen as itself having a history and a politics; the result has been a set of works on the rhetoric of cartography, on maps and ideology, and more generally on the "situatedness" of the map. At the same time, there seems to have been little interaction between the new ways of thinking about the map and the homiletics of the textbook.

A second root of current practice has developed in the United States Census, and in the systems established for the protection of individual records. Over the last several years the Bureau has developed increasingly sophisticated tools, designed to prevent data users from working backwards from aggregate results to individual cases. From an initial set of practices designed to prevent one from using simple arithmetical tools to replace intentionally omitted low-valued cells in matrices, the Census has moved to far more sophisticated techniques of "data masking," ones that move values into adjacent cells and even create dummy households. If these techniques have been primarily aimed at data represented in tabular form, it remains that these techniques have impacts on such data when they are mapped.

A third root of current practice, one related to the last, is the legal and regulatory framework surrounding any release of certain forms of data. For example, by state statute medical data typically may not be released for small geographic areas. Here, too, regulations designed for data released in <u>any</u> form have implications for those data once they are released in the form of maps.

The first part of the project will address current practices of spatio-visual representation. It will address the following questions:

- What are those practices, as expressed in standard textbooks, professional codes, and the like?

- In what ways have government and other organizations used formal systems for the protection of individual data?

- Which national, state, and local laws regulate the release and representation of these data? What alternative methods are used in other countries?

B. The Limits of Current Practice

In one sense, I have already pointed to two limitations of the current practices associated with spatio-visual representation: the homiletics of teaching do not make recognition of the best available understanding of the nature of cartographic practice, and institutionalized practices do not deal explicitly with the question of the ways in which special problems may be raised by cartographic representations. The second part of this project will develop a more thoroughgoing analysis of these and other limitations. It will do so by addressing the following questions:

- In what ways relevant to the ethics of spatio-visual representation are systems of cartography and geographic information systems politically, culturally, and economically situated? What can we learn from the most recent cultural and historical studies of the practice of cartographic representation?

- In what ways does the spatiality of data render ineffective or inadequate the traditional methods of data masking?

- In what ways do normal methods of map reading involve unwarranted or unintended inferences, and are there representational practices (associated with scale, manner of generalization, etc.) that can minimize these problems?

III. Methods

This is a multidisciplinary project. It will involve work in and the cooperative efforts of experts on:

- The cultural studies of science, particularly with respect to the issue of representation

- The legal regulation of medical and other statistical data

- Spatial statistics

- The psychology of map perception

IV. Anticipated Outcomes:

Toward a New Regulatory Regime for Spatio-Visual Representation

On the basis of the answers to the above three questions, the project will finally lay out a general picture of the ways in which one can move from generalized data to cartographic representations, while at the same time minimizing the likelihood of violations of privacy of individuals and groups.

- It will draw on the historical, political, and cultural analysis to address the extent of dangers posed by spatio-visual representation, and to address the relationship between the issues of privacy and of the right to know.

- It will draw upon the analysis of formal methods of data masking to propose alternative models appropriate to spatially represented data.

- It will draw upon the analysis of practices of map reading to suggest protocols for acceptable cartographic representation.

- Finally, it will suggest ways in which this analysis can be formulated into new regulations.

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Introduction

An inherent difficulty in representing and understanding individuals and societies in Geographic Information Systems (GIS) has been the static, land-attribute framework of current GIS. Yet societies are dynamic; composed of disparate and mobile individuals whose interactions lead to emergence of the complex, non-linear phenomena that shape our spaces and societies. The very complexity of social phenomena means that harnessing the power of computers to aid our understanding is far more critical here than it is for the simpler landscape issues traditionally addressed with GIS. Our challenge is not merely to clarify the limitations of current computer representations, but rather to elucidate alternative representations that do facilitate effective representation and integration of the complex relationships between People, Space, and Environment.

Individual-Based Models may offer a more appropriate system for representing and studying many complex social interactions within a spatial framework. Such models enable us to specify individuals and populations of individuals who each have distinct knowledge, needs, desires, resources, information access, locations, abilities, mobilities, and time-specific locations; all within a spatial framework that includes not only spatial and environmental context, but also the context provided by other individuals and their potential interactions.

This is not yet GIS: no system that would currently be labeled a GIS has these capabilities. Yet such individual-based models do currently exist (Santa Fe Institute: Swarm 1995), and in many ways these systems may offer far deeper insights into human geographic phenomena than any current GIS. Perhaps we should deconstruct our usual labels. Still, there are serious questions related to the appropriate use of the strengths of each, and few venues would be more appropriate than I-19 for a thorough examination of both the potential and limitations of this alternative for representing individuals and societies within a formal framework.

Motivation for Individual-Based Models in Human Geography

Traditional geographic models of human settlement patterns typically address one particular era of economic development and available spatial technologies (e.g. Von Thunen, Christaller, Weber, Lowry).

Such snapshot models are useful for understanding spatial relationships in a fairly simple and static world of fixed spatial technologies and one dominant economic sector. Yet if we want to understand spatial interactions and patterns in a world that becomes increasingly complex, and where spatial technologies and motivations for interaction change increasingly rapidly, it will help to have a more dynamic and more general model that captures the relationship between different profiles of interactions, geographic structures, and spatial technology alternatives.

Developing a general model such as the one described above is particularly important if we want to try to make any predictions about future geographic patterns. Just what is likely to be the net effect of new spatial technologies such as the Internet and video conferencing? To what extent are the structural-change elasticities with respect to developments in spatial technology dependent on the relative importances of various roles and on the influence of prior structure? Most profoundly, individual-based simulations have the capability to capture non-linear interactions and dynamic feedback effects that may provide more realistic models of spatial processes. For example, to what extent do positive feedback and lock-in mitigate or exacerbate the influences of prior structure or inequalities?

Research Questions

Individual-based models may be useful at a number of different scales, for example:

1. To explore the relationship between changing spatial technologies, shifting economic sector requirements for spatial integration (post-modern economies), and the response of human settlement patterns and associated resource distributions.

2. To explore social dynamics within neighborhoods and cities at various scales, especially the degree to which isolation or diversity enhance or inhibit the evolution of cooperation and understanding.

3. To explore the social and economic implications of differential access to specific resources and especially to information technologies, for different groups in different spatial and economic situations.

Sample Model for Spatial Technologies and Settlement Patterns

Let each agent correspond to one individual human (not groups). Groups of agents may in turn be associated with different social groups, but interaction is fundamentally at the individual level. Initially, each agent is represented by fixed preferences, abilities, mobility, and resource requirements. Information (and derived knowledge) are determined endogenously according to each individuals access to sources of information, which can include differential access to specific technologies and networks (see the NCGIA Inner-Cities Access Project). Later, adaptive agents may have the capability to modify their behavior according to experience.

I posit that many spatial distributions of individuals can be captured by the following framework, and that there exist secondary evaluations related to fairness, resource allocation, and social and environmental sustainability that may in turn be associated with the distributions that evolve.

1. landscape, consisting of site and situation

   site: attribute functions defined over space (either over
   nodes or   over plane)

   situation: spatial technologies and infrastructure that affect
   access   from a site

both site and situation may have elements that are either exogenous or endogenous

2. agents, with access requirements and personal preferences defined over site and situation. Access requirements determine agent types, whereas personal preferences may be distributed randomly (or not) across agents: access requirements determine agent types (all models)

   site: agent requirements for site resources or conditions

   situation: agent requirements for spatial access to one another
   and/or   to resources

personal preferences (added to later models) are defined by

   site: agent preferences over site characteristics

   situation: agent preferences for spatial access to one another
   and/or   to resources

3. population characteristics -- the proportions of agent types within the population

4. rules, pertaining to agent actions and feedback effects

agent actions:	agent actions as a function of agent
perceptions of	landscape characteristics and
population	distribution
feedback effects:	landscape characteristics as a function of
agent	actions

5. prior structure (optional), specified by additional landscape configurations and/or population distributions (includes both proportions and individual location)

Questions for Initiative 19 -- Representing Individuals and Societies

With respect to the development of theories about the relationship between economic and social interactions, spatial technologies, and geographic distributions, individual-based simulation models have the potential to provide us with laboratories within which to conduct controlled tests about the effects of alternative specifications of specific individual characteristics, geographies, spatial technologies, and interactions thereof. To what degree do the models predictions correspond to what we know about historical conditions and resultant phenomena? Our challenge is to delineate representations and conditions under which individual-based models may provide useful insights with a minimum of distortion or misrepresentation.

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The primary goal of this paper is to examine whether geographical information technologies contribute to the domination and marginalization of both natural environments and human populations. Of concern are what Winner (1986 p. 22) calls "inherently political technologies" which are human-made systems that appear to require or to be strongly compatible with particular kinds of political relationships. Whether maps and other geographical information technologies can be characterized in such a way is considered.

In this paper it is hypothesized that geographical information collected and controlled by the state or other authority, in addition to, or in place of, the threat of military or other forceful response, often forms a primary means by which control over the access to and the utilization of particular land resources and territory is established and maintained. The political power inherent in this information is considerable. Understanding how geographical information is utilized is essential to gaining an understanding of how a state functions with respect to its land resources and to the populace that has a vested interest in these resources.

In order to demonstrate the socio-political power in geographical information technologies, this paper draws upon an example relating to India. There are a number of justifications for the selection of this geographic context. First, the introduction and use of surveying and mapping, essentially European technologies which had minimal cultural precedence in south Asia, played a significant role in the domination of India and its natural resources by imperial powers. Often, throughout the imperial period, the stated purpose of the introduction of a particular geographical information technology was for the betterment of the population. This could be through fairer land revenue assessment, better resource management, alleviation of poverty, or more efficient administration. Yet, these objectives were rarely achieved. Land revenue assessment remained unfair, resources continued to be poorly managed, poverty continued unabated, and administration remained inefficient.

Second, because of intense population pressures on the natural environment in contemporary India, the introduction of better geographic information handling capabilities is often promoted strongly as an important component in any sustainable development strategy. However, in promoting such technologically based approaches, the underlying assumptions and political biases of information technologies are rarely considered. These inherent assumptions and biases may be, in fact, incompatible with many objectives of sustainable development and may be influenced strongly by the imperial legacy of the land information technologies that have preceded them.

Various areas of knowledge can be drawn upon to support this assertion. These include recent work in political ecology and the history of cartography. Together, elements from these areas provide the perspective from which historical and contemporary aspects of the introduction of geographical information technologies in India can be examined. From political ecology comes the notion that ecological impacts, and human responses to these impacts, are, in a large part, influenced and defined by political factors. In India, historically, one of the most important of these factors has been British imperialism. One of the important means by which imperial ambitions were facilitated was the development and use of various forms of geographical information technologies. Recent work in the history of cartography, most notably that of Brian Harley (1988; 1989; 1990), has indicated that European surveying and map-making activities played an important role in achieving and maintaining control over foreign territory. Harley's work can be extended to provide a framework for assessing contemporary developments in geographical information technologies, most notably geographical information systems and remote sensing, and the way in which they are employed in an area such as India.

One example from contemporary India which can be considered with respect to the socio-political aspects of geographical information concerns the national programme of wasteland mapping and rehabilitation. The British introduced a notion of wastelands which was a category describing lands which did not yield revenue to the imperial administration (Shiva 1989, p.85). These lands were further characterised as being either cultivable or non-cultivable, the difference being that the former were judged to have the potential for cultivation whereas the latter were not (e.g., bare rock, glaciers). No account was taken in the classification of suitability for cultivation (or other activity) nor was consideration given to ecological factors such as biological productivity. Here the political ecology of contemporary approach to wastelands is examined with particular emphasis upon the role of advanced geographical information technologies in their treatment. Specifically, the questions of whether recent wasteland mapping programmes are substantially different in focus from imperial surveying and mapping activities in terms of objectives, methods, and expected outcomes are examined.

In 1985, then Prime Minister of India, Rajiv Gandhi, established a national program with the object of bringing five million hectares of land every year under fuelwood and fodder plantations (NRSA 1986, p. 9). A significant component of this program was extensive mapping of the wastelands.

The first national wasteland mapping project undertaken by the National Remote Sensing Agency (NRSA) involved a national mapping project at the scale of 1:1 million. Using Landsat Multispectral Scanner (MSS) imagery from 1980-82 (80 metre spatial resolution), a standard classification scheme for the entire country was developed and area estimates of each wasteland category were made at both the state and the national levels. Using information from this initial mapping, 146 districts in the country deemed to be critically affected by wastelands were prioritized and mapping was carried out at the scale of 1:50,000 (NRSA 1991, pp. 25-27). The 1:50,000 scale wasteland maps produced by the National Remote Sensing Agency were prepared by visual interpretation of enlarged Landsat Thematic Mapper (TM) False Colour Composite (FCC) imagery (1986-87 period - 30 metre resolution) generated from Bands 2, 3, and 4

(green, red, and near infra-red portions of the spectrum) (NRSA 1991, p. 3). Additional districts were later mapped using Indian Remote Sensing (IRS) satellite data (LISS-II - 36.5 metre resolution) instead of Landsat data. There is no other country which has undertaken such an effort to catalogue the extent of land degradation.

One definition of wastelands used by the National Remote Sensing Agency is:

> ...degraded land which can be brought under vegetative cover with reasonable effort, and which is currently under-utilised and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed disabilities such as by location, environment, chemical and physical properties of the soil or financial or management constraints. (NRSA 1991, p. 2)

As with imperial definitions of wasteland, classification is generally in terms of agricultural activity. The two-level classification system used by the National Remote Sensing Agency for their wasteland maps is shown in Table 1. An important characteristic of the wasteland categorization utilized by the NRSA is that it has been standardized for the entire country. This was viewed as desirable as it would allow for national estimates of wastelands to be consistent. However, considering the incredible biodiversity of India (see, for example, Gadgil 1993), it is questionable whether such generalized categorizations will be useful for actual rehabilitation efforts on the ground, which is stated as the raison d'et're of the 1:50,000 scale wasteland maps.

TABLE 1. Wasteland Categories

LEVEL I	LEVEL II
1. Culturable Wastes	
	1.1. Gullied and/or ravinous land
	1.2. Undulating plain with or without scrub
	1.3. Surface water logged and marsh
	1.4. Salt affected land
	1.5. Shifting cultivation area
	1.6. Degraded forest land
	1.7. Degraded pastures/grazing land
	1.8. Degraded non-forest plantation land
	1.9. Strip lands
	1.10 Sands
	1.11. Mining/industrial wastelands
2. Unculturable Wastes	
	2.1. Barren rocky/stony wastes/sheet rock area
	2.2. Steep sloping area
	2.3. Snow covered and/or glacial area

Source: National Remote Sensing Agency 1986, p. 14

In the national wasteland mapping project, there is no assessment of capability nor suitability for agriculture or any other activity. This classification system is essentially a descriptive one with respect to land cover. Without consideration of the capability (whether an activity can be supported in a given location) or suitability (whether an activity should be done), it is unlikely that rehabilitation efforts based upon this information will be appropriate to local ecological conditions.

As elsewhere in the world, the explanations of environmental degradation in India are often contested. For example, many Indian government and forestry officials view deforestation as largely the result of increasing population pressures whereas Indian environmentalists and social activists contend that deforestation stems from increasing commercialization of Indian forestry (Haeuber 1993, p. 486). The wastelands mapping project by NRSA is an expert-driven, top-down initiative with very little local involvement. Such a structure does not readily admit a diversity of perceptions as to what constitutes degradation. As Blaikie and Brookfield (1987, p. 16) have argued,

> There are competing social definitions of land degradation, and therefore the challenge of moving away from a single "scientific" definition and measurement must

be taken up. This means we must put the land manager 'centre stage' in the explanation, and learn from the land managers' perceptions of their problems.

The wastelands mapping programme of the National Remote Sensing Agency does not do this. It also does not take into account local patterns of land use, nor the role of common lands for meeting the subsistence needs of the poor. As Indian ecologist Vandana Shiva (1989, p. 83) comments:

> Recovering five million hectares of the commons in India each year could signal the end of rural poverty and a reversal of the ecological collapse of critical life-support systems like soil, water and vegetation. Yet the wasteland development programme, far from being a recovery of the commons project, will in fact, privatise the commons, accentuate rural poverty and increase ecological instability. In one stroke it will rob the poor of their remaining common resources, the only survival base to which they have access. The usurpation of the commons which began with the British will reach its final limit with the wasteland development programme as is.

Most geographical information technologies, by their nature, are biased in favour of the already powerful in society and are not readily conducive to the agendas of participatory local development or democratic governance, for instance, which are often cited as preconditions for sustainable and equitable development. This is particularly true of the new digital technologies, contrary to the views of many geographic information system and remote sensing practitioners. It seems certain that geographical information technologies will play a significant role in India's efforts towards sustainable development (as well as in other locales). The ways in which these technologies will be employed still remain uncertain.

Continuation down the present path of technological development will most likely help perpetuate the present socio-economic and political inequities which exist. The beneficial (however defined) use of these technologies will require much closer attention to the issues raised here than has previously be given.

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The focus of this project is on the importance of geographic information in the current indigenous struggles in southern Mexico. In the state of Oaxaca, many indigenous movements center on the attempt to construct so-called 'autonomous regions'. They attempt to address the marginalization of indigenous communities through the construction of new political units, in which indigenous traditional laws and culture take precedence over state and some federal laws. This movement is related to the armed uprising of Zapatista rebels in the neighboring state of Chiapas, which also has indigenous rights and local autonomy as a key demand. A key issue is the relationship between indigenous communities and the existing administrative structure, specifically if these regions should be based on current district boundaries, or if new regions should be created. As such, the current negotiations between local groups and the Mexican government to create these regions involve the consideration of a variety of factors, including cultural, ecological and political concerns. Of crucial importance is how these issues are represented at the negotiating table. The way in which geographic information is produced and disseminated has a deciding influence on the outcome of these local struggles.

In this context, the importance of what counts as geographic information and how it is produced comes to the fore. A narrow definition of GIS in which only the analyst as the expert has the power to define the representation of issues limits local participation to circumscribed points in the production of geographic knowledge. On the other hand, if the definition is broadened to include systems of communications that convey and produce geographic information, the space is opened up for contesting representations in which marginalized movements can produce alternative versions to contest dominant representations. This has happened very effectively in the 2 year old uprising in Chiapas, where representations produced by the Zapatistas have been reproduced and disseminated through a variety of media, including the Internet, thereby challenging the attempt to localize and narrowly define the object of negotiation.

Attempts at using GIS in conjunction with social movements have often focused on the problem of incorporating other knowledges into existing GIS. The problem is that through this approach the social relations of the technology, i.e. the role of the analyst and the constrains of technology, often go unquestioned. Situating GIS within the wider field of communications and the production of geographic knowledges, illuminates the role of contemporary GIS and its embeddedness in current social relations without privileging the technology. It becomes one way of producing geographic knowledge, rather than a privileged form of representation. In this context, the current social struggles in southern Mexico provide

an illustration of the role of GIS. They clarify the effects of using GIS in a context in which the state and social groups are in conflict.

States have long been the primary producers of geographic information, and have often sought to present in ways that would benefit certain social groups and classes. This is especially true in Mexico, which has historically struggled to create a unified nation state. With the advance of GIS technology and its barriers to participation ranging from cost to skills, the privileging of sophisticated information automatically favors the producers of this information, in this case one side of the conflict, even if other knowledges are incorporated. It seems largely impossible that peasant movements can compete with the resources of the state in producing sophisticated, 'objective' information. A different strategy, rather than to resort to a war of technology in which the state is clearly favored from the outset, is to rely on alternative productions of geographic information to question the primacy of largely state-owned and produced information. The issue then moves from the incorporation of knowledges into existing systems, and thereby acknowledging the superiority of technology drivenknowledge, to the contestation of particular knowledges.

In the general drive for more sophisticated information, it is often forgotten that geographic information about localities is produced and transmitted by local populations in a variety of forms. This has traditionally been confined to oral history, or generally to informal networks to be investigated by anthropologists. But there are also technologies that can be used to transmit differing accounts, from local newsletters to the Internet. The Chiapas uprising has demonstrated the utility of the Internet as an alternative route of producing accounts of the conflict and the issues involved. The EZLN and sympathizers with e-mail access have managed to increase the scale of knowledge, refusing to let the conflict be confined to a mere question of regional inequality. The Internet, a system with multiple access points and potentialities for the production of knowledge that do not necessarily favor one particularly trained expert, has proven useful in directing international attention and thereby constraining the possibilities for action by the Mexican government. In this struggle in cyberspace (a 'war of ink and Internet' as one Mexican official called it) geographic representations are contested. I do not want to suggest that the Internet by itself is a social equalizer, but the use in this particular conflict points to the potentials emerging in this technology. This clash of different versions in cyberspace is vastly different from the attempt of incorporating local knowledge into an existing system, in which the analyst plays the role of gatekeeper, while she/he is constrained by the technology itself.

The issue then moves away from constructing the perfect GIS in which all knowledges are represented as a perfect mirror of the world, or as a tool around which liberal notions of negotiation and compromise can be deployed. The traditional barriers (i.e. expertise, money, access to information) favor particular institutions, in this project certainly the state. The point is then not to try to compete on the same level, but rather putting GIS in its place by validating other knowledges that are difficult or impossible to be represented because they are produced under different circumstances than the technology-heavy knowledges of current GIS.

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Research Interests and Plans

My research and publications have addressed three of the conceptual issues outlined in the "Call for Participation", namely the representational logic of GIS, the proliferation of spatial databases, and the ethical issues in GIS research (Goss 1994; 1995a ; 1995b). I have been particularly concerned with the application of GIS as a central component of geodemographic marketing research. The business application of GIS is said to be the fastest growing segment of the industry and there are a number of large corporations selling integrated spatial databases, GIS, and decision-making tools which represent consumers as objects in abstract space to be "scouted" and "targeted" by a strategic intelligence. I have critically examined the metaphors employed in the promotional discourse and the conception of reality that is presumed in these systems. I have argued that the representational logics reproduce technical power over social life.

This "deconstruction" of geodemographics, however, is of limited value if it is not communicated to practitioners and use to reform practice. My concern now is how to incorporate this critique into pedagogy, and I have committed to developing a course to teach a more responsible retail and marketing analysis. With Matthew McGranaghan I am developing an course on spatial analysis for business applications that will draw students of geography, urban and regional planning, business, and tourism industry management using an instructional version of Claritas' Compass (one of the major geodemographics systems) which is now available through the Kansas Geographic Bureau. The course will be initially offered at the graduate level.

The goal of the course, which will be team taught, is to teach concepts and techniques involved in geodemographic systems as well as basic spatial analysis, with a particular concern over the assumptions behind them and the effects of their application. This will include consideration of data sources, database management, and questions of privacy; computer cartography, GIS, and questions of representation; aggregation, areal units, and problems of ecological inference; and ethics of marketing practice. The idea is not to reject the methods entirely, but to encourage responsible use, as far as that is possible, and I believe that geographers sensitized to social theory are best equipped to do this.

I would like to discuss this proposal with others who teach GIS and who have attempted to integrate philosophical and political concerns into their classes. I suspect that in most cases, practitioners have

added a "critique" section to the course rather than integrating these concerns thoroughly from the outset. This is perhaps difficult given the main purpose of instructing in methods. In the proposed course, however, the primary initiative comes from a critical perspective, and the goal is to teach critical theory around the methods of GIS and geodemographics.

Although concerned primarily with pedagogy, this does raise issues of evaluation and hence pedagogical research--how effective will such courses be in communicating critical theory and reforming marketing practice? In addition, it is expected that students and the instructors will conduct research on issues of representation in the context of this course. In particular, we will directly investigate the validity of the representations of social life and social space in geodemographic systems and examine the potential of such systems in social science research. The context of Honolulu has, in fact, proven challenging for geodemographic analyses due to the complexity of the multi-ethnic population and the relatively recent penetration of large scale retailers.

A fourth conceptual issue identified in the "Call for Participation" addresses how GIS can be used in decision-making to represent the needs of marginal groups. In my work I have not thus far considered the "progressive" use of GIS in participatory research or conflict resolution, but I have several graduate student advisees who are presently conducting or developing research on community resource mapping in Indonesia, and consequently it is a topic about which I am learning more. My students are evalua ting the work of environmental NGOs in Eastern Indonesia and I have been impressed with their reports on the use of mapping as a tool in consciousness raising and developing local resource management institutions. I have also been influenced by the work of Jeff Fox and his associates (1994; 1995) and Nancy Peluso (1994) on community resource mapping in Indonesia, the former in particular using GIS effectively. I am not sure how much success depends upon the techniques themselves, as opposed to the environmental initiative and the potential empowerment of simple mapping exercises, but certainly GPS integrated with GIS would make the mapping less labor intensive. The question remains, however, of how practicable GPS/GIS based mapping will be in a mountai nous rainforest environment (even if it is certainly more so than conventional field mapping) and how "sustainable" the mapping might be given the lack of access of isolated communities to the technology and their dependence on outside expertise to conduct the research.

I am planning to take a sabbatical year in order to study transmigration in Eastern Indonesia and I am interested in incorporating a community mapping element in my research into adaptation on the agricultural frontier, in a context of intense resource conflict. The larger study examines processes of socio-economic differentiation which inevitably involvels investigation into land acquisition and use, and relations with indigenous people. Although, not the primary focus of my research, I intend to use GPS/GIS to document the land use conflicts between the transmigrants and indigenous populations. Detailed land-use maps have been made by government consultants, but these, needless to say, do not seem to conform with the "mental maps" of transmigrants or indigenous residents, nor necessarily to structure their territorial activities. The transmigrants frequently exploit forest resources outside of their assigned land

rights and the indigenous people, who are primarily gatherers and shifting cultivators, range extensively in the forest. The situation is further complicated since the area of investigation is the site of a national park (with a large number of endemic species and an climate-vegetation zonation from tropical swamp to alpine scrub) and logging concessions held by corporations headquartered in Jakarta.

The first task is to map the property and land use claims of the various interest groups and to identify areas of overlap. This will involve using GPS to map the resources of the indigenous people and transmigrants, and overlaying these with ditigizations of the maps produced by the national park authorities and forestry ministry. The first task will necessitate living in a mountain village, travelling with individuals to make resource inventories, and consulting with focus groups composed of villagers. Much of the mapping work will be undertaken by a graduate student together working on a thesis together with a junior faculty member of the local university (Universitas Pattimura).

The primary goal is to map the resource claims of the indigenous villages and identify areas of systematic encroachment. I do not presume that GIS can capture the total spatial experience of the indigenous people for I am well aware that GIS effects a particular representation of the world. I recognize also the dangers of reification involved in mapping of territory and present resource uses. However, in this case I suspect that some form of objectification is necessary to establish the legitimacy of traditional resource claims and to document points and sites of conflict. This will entail a mapping of current active use of resources, past use of resources, and intended or potential future use of resources. It will also involve mapping time-space pathways of resource-expoiting acitivites in the forest.

There are, in fact, some obvious cases of resource conflict, such as the protection of bird species in areas of the national park long used by the indigenous people for trapping (exotic birds are their main source of cash income); the "illegal" logging of trees by tranmisgrants in both the national park and under "sharecropping" agreements within the village territories of the indigenous population; and the development of permanent agriculture by migrants in the lowland sections of the village territories. Mapping the customary claims of villagers and areas of conflict will at least provide a basic inventory that can be used in negotiations with the national park authorities, the transmigrants, and the loggers, although outcome of negotiations will inevitably depend upon interpretations of the complex land law and definitions of national interest.

These two future pedagogical and research goals fit with two of the research themes of the Specialist Meeting, namely the administration and control of populations and the political ecology of natural resource access and use. My "position", then, is that I remain extremely suspicious of the practice of geodemographics, but wish to both teach its limitations and investigate its potential for alternative research applications; I remain suspicious of the representational strategies of GIS, but believe that a part of my objection to GIS is that it has been mainly applied for the purpose of social control rather than empowerment. I realize that the form of representation of reality in GIS contributes inevitably to a particular way of seeing that lends itself to surveillance and social control, but also believe that that in come contexts the strategy may be turned against itself. We have to at least explore such possibilities.

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Technology is gendered. From the philosophy behind it, to the design and construction of it, to the uses to which it is put, to the social structures it uses and supports, technology incorporates gender. Feminist theory, and especially the work on women and technology, asks the fundamental question of <u>how</u> technology is gendered. How do the machines, methods, and social organizations of technology reflect, support, or undermine gender roles? With specific focus on geographic information systems(GIS), what are the impacts of this gendering on women as geographers, as GIS practitioners, and as the focus of geographic study?

Feminist theory provides various paths of analysis when focused on GIS. Three distinct categories emerge: (1) the impact that GIS has on the status of women in geography (here I focus only on academic geography, but clearly the status of women in the private sector is also affected); (2) the visibility of women in GIS-centered research; and (3) feminist critiques of science, epistemology and methodology (the praxis of GIS). I will briefly outline the types of analysis which can illuminate each of these topics.

(1) The Jobs in Geography listings make clear that skills in GIS are becoming increasingly important as a prerequisite of academic jobs; female representation among <u>GIS</u> faculty is lower than female representation among geography faculty. It may be that the gains in status that women have made in geography are eroding because they do not utilize the technology to the extent that men do. In addition, GIS has added a masculine layer to the culture of academic geography. With the introduction of computer science (the basis of GIS technology), the masculine computer culture spread into geography more than it would have with less intensive use of the machines. Many women avoid this culture, not only because they may not have the background and skills necessary to function in it easily, but also because the masculine climate created can be an uncomfortable one in which to work. Researchers in women and computers posit that women may actively avoid computer-intensive work, opting instead for a work environment which is more personally interactive and for research topics which are more contextual (e.g. Lloyd and Newell, 1985). This does not bode well for the future of women in a geography heading for increased use of GIS.

The history of the workplace demonstrates that as certain jobs are deskilled, they are assigned to women (e.g. Cockburn, 1985). Thus certain skilled industrial processes were broken down into a series of unskilled procedures which were then given to women to do at much lower wages. Although computer programming was initially considered a clerical (female) task, it was reassigned to men when it was

professionalized. Currently, the level of skill in programming is again being reduced - just as an increasing number of women are entering the field. Within GIS, it is perhaps too soon to tell if a similar pattern will emerge. With more and more private companies adopting GIS and a growing number of women trained at the baccalaureate and masters levels, things could conceivably go either way: women could become established as GIS professionals, or they could be assigned to 'clerical' GIS functions. Note that 'clerical' in this context does not necessarily refer to mindless digitizing or data entry. GIS is following the path of computer programming in that tasks which were previously highly skilled are now more automated and thus less skilled. The historical and current patterns of the work force suggest that this second path is more likely. Within academic geography, a similar pattern could emerge. GIS is increasingly a skill which geographers are expected to possess, yet the highly technical aspects -- as opposed to the skills for use or application -- may constitute a separate category: a category made up predominantly of men. A predictable outcome would be a power/influence/funding differential with distinct gender characteristics.

(2) Since feminist geography emerged in the 1970s and 80s, the discipline has been giving increasing acknowledgement to how women have been hidden in much of traditional geographic analysis, thus leaving women's lives unexamined. Feminist geography is working to fill in those gaps. GIS research becomes problematic, however, since it often depends at least in part on existing databases. Census records, for example, tend to obscure women's lives by building certain assumptions about roles and activities into the questions and categories. Few existing data bases contain as complete data about women or other marginalized groups as they do for dominant groups. Including true measures of women's lives needs to be an intentional and deliberate project. Even then there are questions if the discrete design of computer data sets can accurately capture the complexities of (especially marginalized) lives (e.g. Damarin, 1993).

It is not only demographic or social science data sets which hide gender differences. Natural resource data sets can also obscure women's lives and women's interaction with their environments. Rocheleau (1995) describes how satellite images of land use can easily conceal women's use of that land. With out a deliberate search for alternate methods, the gendered nature of both land use and land use maps would remain invisible. This was not a situation whereby a data set could be tweaked to reveal new information. The remotely sensed data layer had to be supplemented with a ground up view.

(3) Feminist critiques of science, its epistemology and methodology can also be used to shed light on gender issues in GIS. GIS is born of positivist science, a model which feminists, among others, have found inadequate. Other ways of creating knowledge are necessarily included in feminist methodology; GIS has not yet incorporated them. Computers are designed to use neat, clean, mutually exclusive categories. This vision of reality built into the database is reflected in the binary design of the machine itself. Feminist researchers of science, on the other hand, look to fluid, changing and possibly conflicting views of the world. If we force these knowledges into the designed structure of the computer, something must get lost.

I suggest that GIS become one method in a more inclusive methodology, one which insists on including other types of knowledge. There is no reason that GIS structure need determine an entire research project. While GIS can be a very useful technology, other forms of knowledge which resist GIS/computer structure can certainly be incorporated. A recipe metaphor is useful here: certain knowledge is to be put through the data processor, but other knowledge must be carefully folded in by hand. Without both of these steps, the final product is not complete.

Clearly these gender issues intersect the concepts chosen for the Specialist Meeting. If all social action is gendered, as I contend, then GIS praxis will contain gender issues. I add just a few other comments. Concept (3) asks how the knowledge and need of marginal social groups can be incorporated into GIS-based decision making. I would add a prior question: <u>can</u> that knowledge be incorporated into current GIS praxis without major and/or detrimental transformation? If we foster a change in GIS praxis to a more inclusive methodology, the needs of marginal groups might be better served. Administration and control issues surround this technology as well, not only in terms of who controls the research, but also in terms of who holds power within the technology itself. Without a full understanding of that dynamic, a full understanding of the possible utilization of the technology by others is less likely. Gender issues embedded in data collection and database construction, for example, are relatively easy to identify and analyze <u>if</u> someone looks for them. But biases held within the technology resulting from the world views of the designers are harder to ferret out. Women's position outside technology can help to illuminate these issues for other marginalized groups as well.

My dissertation, "Theorizing GIS: A Feminist Perspective," (expected completion August, 1996) explores these issues as well as other topics in GIS which can be illuminated through feminist theory. I am interested in studying this technology from a science and technology studies (STS) perspective: how does GIS compare with other computer-based technologies and with technologies throughout history? If technology is inherently a means to dominate nature, how can we reconcile that philosophy with what we would like to be an environmentally friendly geography? And, especially, what are the gender issues embedded in all of this?

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Commenting on virtual technologies, communications theorist Frank Biocca (1992) makes an observation that equally applies to the technical/theoretical trajectory of GIS when he notes that a developmental logic, operating as a set of goals for the technology's future, already circumscribes different versions of cyberspace under development. Geographers such as David Martin (1991) and Michael Goodchild (1995) variously note GIS's lack of theoretical basis, or that the technology itself motivates research questions. Veregin (1995) finds a paradox in the materialization of a technology's greatest impact only when it seems to recede from cultural view. However, there is no paradox here, for theories and philosophies, like places, achieve greatest affect when they recede into the background and are naturalized. For a technology, this only occurs if it is informed by a theoretical matrix that is part of deeply ingrained beliefs taken as givens, or 'facts.'

The observation that conscious theorization has not led to GIS technical advances should not lead to assuming that the technology is theory or value neutral. To do so would exemplify a view that all technologies are only intermediaries or conduits for diffusion that leave the 'information' transmitted essentially unchanged. Critique of GIS as technology-driven might consider that workers in this field, as in the natural sciences and mathematics, compare and organize data and this activity in itself constitutes a method, if not a theory. However, as reading Reports from NCGIA's Initiative #2 confirms (Mark and Frank et al, 1989) theories of knowledge underpinning Artificial Intelligence (AI) research and development - of direct interest to GIS as a practice - must be rethought.

Hubert Dreyfus (1992) notes the continued assumption within AI research of a Cartesian model of mind defined by its capacity to form symboli representations of all domains of activity. An actor defines a problem, extracts relevant data from available information, and develops a plan. As a method of information retrieval, this is how one uses a Rolodex, and describes, for example, the work of students who meticulously consider each fact before arriving at tentative conclusions. Over time, however, in grappling complex issues, humans learn to sort through less data rather than more. An experienced surgeon may perceive quickly what needs doing without recourse to second opinions or expensive testing. Once know-how of social and technical skills is acquired, one bypasses the stage of sorting through appropriate actions necessary at earlier stages of knowledge acquisition. The advantages of the connectionist models of AI and neural nets, suggested by George Lakoff to Initiative #2 as a promising avenue of enquiry, lie in an ability to learn from experience. Neural nets recognize patterns and pick out

similar cases, but unless the array of generalizations at which they might arrive are restricted in advance to conform to ones that humans might make, nothing precludes neural nets from arriving at logical conclusions that make no human sense. It is necessary to preclude certain generalizations in advance. This poses less difficulty when extrapolating, for example, zoning by-law data across an array of jurisdictions and times. Applied to a GIS modelling a society composed of individuals and groupings whose intelligence is based on imaginative generalizations drawn from fluid contexts holding together in relational fashion both continuity and change, and both at once, the net would reflect the bias of the operator who predetermined which generalizations were appropriate.

To model social attitudes, for example, which may not be 'visible', creates a discrete thing out of what was a less bounded social process. An emphasis on modelling in lieu of deliberative description must attend to the indeterminacy and fluidity of social relations. Ironic as it may seem, representations of society must be somewhat inexact if they are to have any claim to saliency. Of particular interest to me with regard to Issue one, is how language conceptually is 'positioned' within emerging GIS theory, and how this will influence future applications. The notion that 'language structures space' works to organize language as a human technique. Considerations of its ability to suggest relational connections with the broader lived world around us are deflected. I understand linguistics' earlier use of 'structure' as emphasizing particular and complex organizations of relations in a living language process taking place at deep levels. Structure, however, expresses something fixed, permanent, and hard, though its use in American linguistics intends the sense of internal formal relations in a language (Williams, 1983). Such structures are believed to define features of human consciousness, and as Initiative #2 Reports reflect, the human brain. A difficulty with structural metaphors lies in the risk of mistaking categories of thought for physical substances. Psychoanalytic generalizations of human nature are associated with rationalist generalizations of properties of mind and with forms of idealism. Though language precedes the sharp modern distinction between nature and culture, in many ways, expressed in oral speech -- along with the body -- it is a hybrid that joins nature and culture, and this is the source of its synthetic power. To reduce it to a structuring mechanism of space suggests that concrete reality is only a language construct fully reducible to sub-units of information or data that can exist most efficiently in machine form.

As the human operator's need to delimit generalizations available to neural nets suggests, modelling society demands close attention to the values underlying both the production of data and their selection. Data are implicated within a broader context of social relations -- conceptions of space and language included. To believe data might be value free suggests a credulousness, or a misplaced faith that they exist in a natural state like rocks or trees. They are not composed of the same substances as that which they represent. Data are more like metaphors or 'mappings' which equally can serve to disguise or mask the spaces they represent, as to reveal invisible particularities in spatial form. Openshaw (1991), for example, almost suggests the value neutrality of data. He implicitly subscribes to a theory of communications based on a conduit metaphor. Meanings and linguistic expressions become objects. Like early cybernetic theory based on closed systems, failure to communicate is not even 'noise' but a

subjective error in data transmission. However, (if how metaphor is used is of concern to GIS theory) there is a need to consider GIS as both a language and an environmental metaphor.

The NCGIA's search for a theory of spatial relations must remain broad enough that any eventual theory not be only an 'ultimate', reductive definition of reality that would readily factor into the data crunching technology, thereby subsuming reality into its representation in a communications format. There is a wish to make geographic theory clearer and more definite. Certain aspects of spatial analysis, and GIS specifically, exemplify a yearning for the recurrent philosophers' illusion of absolute clarity. However, a metaphysical leap based on assuming that data driven technologies will themselves 'produce' knowledge ought to be avoided. It assumes that humankind's material and imaginative extensibility corresponds to something quasi-immaterial which then is translatable without loss into iconography and picture-language. Such a premise also is based on mathematical reasoning wherein "I have no concept at all of my object until the definition provides one" (Copleston, 1994:191).

The NCGIA's interest in reasoning and language is intriguing and timely, in view of the fact that grammar development follows the use of language. Considered as a visual language, GIS applications that model society will need to elaborate grammatical rules. This will require considering the living nature of language. Language is more than a method or outcome of a use. Its status as a human practice must be factored into any model that does not wish to overly freeze fluid social dynamics. There may be many aspects of society that are not suitable for GIS modelling, at least not using current technological forms.

In the context of GIS and Society, the key issue of data ownership assumes heightened ethical and political importance, for these data are representations of people. Geography, with its emphasis on pattern, has tended to abstract people. Given the commercial and military clienteles for GIS, Initiative #19 needs to consider how this tradition may contribute to undesirable occlusions of the people who form part of society, and to initiate dialogue intended to minimize this. Where does the data come from? How much is necessary to produce a clear model, given that, in the case of the disadvantaged and underdeveloped, there is a relative paucity of material? At the service of administration and control of populations, GIS will enjoy State and corporate support in gathering data for surveillance mechanisms analogous to a virtual panopticon. This would still be true for modelling locational conflicts involving disadvantaged populations. Modelling such conflicts ought to be informed by deliberation of who decides what is a conflict, and its extent. Who decides the nature of disadvantage, and might the disadvantaged have a say in defining how the technology will be applied to them, or have the opportunity to put it into 'praxis'? Or will they only to be made subject to GIS technology and practice via their inclusion as data?

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My work as a cadastral cartographer forms the basis of this research. That work led to an examination of the practical considerations that an individual confronts in the task of updating location in the land parcel network within a digital cartographic environment. Such research entailed reviewing the role that the assessment cadastre plays within the land information metasystem of local government as typically encountered in thee United States. I reached two major conclusions: first, there exists a practical need for maintaining current and historical knowledge of location within the land parcel network, which has an impact on other users of land information systems in local government; second, there is a social aspect to the way these systems are set up and used, which has an intricate and subtle relationship with the implementing technologies.

This second realization led into consideration of postmodern critiques of cartography and geographic information science. I also made use of regulation theory, with its concept of societal paradigms, to discuss the transition in cartography and geographic information science from a modern (Fordist) to a postmodern worldview -- a transition that still lies in the future.

In regulation theory, Alain Lipietz, notes [1994, p. 338] that when we turn to the future, we are no longer in the position of "discovering" the prevailing societal paradigm. Rather, the researcher identifies contending paradigms; the activist promotes one as against another. Lipietz identifies two potential successors to the Fordist "hierarchical organicist" paradigm: liberal-productivist (hierarchical, non-organicist), and "alternative" (non-hierarchical, organicist) possibilities.

I used the schema presented in Foucault's "archaeology of knowledge" (as described in Gordon [1980, pp. 243-250] -- substituting the term "agendas" for Gordon's "programmes") to articulate the conditions favoring two different sets of cartographic agendas. The first set of agendas includes representationalism and normalization (characteristic of the liberal-productivist societal paradigm); the second set includes anti-representationalism and plurality (characteristic of Lipietz's "alternative").

Which of the contending societal paradigms (and which set of cartographic agendas) will prevail depends in part on the availability of enabling technologies of power/knowledge. I posit that, for the "alternative" cartographic agendas, one such class of technologies includes those that facilitate the modeling and display of novel geographic and spatial metaphors; I name this category technologies of metaphor. Under

this category I place programming languages, especially very high level languages (VHLL) using object-oriented or logic programming paradigms.

In approaching metaphor, I adopt Rorty's view (following Davidson), placing it "on the model of unfamiliar events in the natural world -- causes of changing beliefs and desires -- rather than on the model of representations of unfamiliar worlds, worlds which are 'symbolic' rather than natural. [Davidson] lets us see the metaphors which make possible novel scientific theories as causes of our ability to know more about the world, rather than expressions of such knowledge." [Rorty 1991, p. 163]

The expression of metaphors is not limited to natural language. If a technology is itself a language, a symbol system, a generator of texts, then metaphors can be expressed in that medium. Perhaps the most intriguing example of this type of technology, in terms of the present context, is mapping. Mappamundi and fantasy maps are obvious examples of metaphorical statements expressed in maps. But so -- when they first appeared -- were highway maps.

A computer language, as a symbol system, also generates texts, including graphics (including maps), sounds, code, and linkages between these elements. All of these are, potentially, means for presenting metaphors. Indeed, within software development, the whole enterprise of user interface design is a continual search for metaphors that will convey to the user what the application "is" and how it may be usefully approached. As a result, we have desktops, menus (which in previous times were encountered exclusively in restaurants), folders, and trashcans.

In my dissertation, I presented object-oriented (o-o) software development as a technology of metaphor. In addition to its capabilities as a technolgy that can build applications that in turn generate texts, the object-oriented paradigm allows much closer coordination between developers and end users. In some cases this enables agencies or groups to undertake software development projects in-house for which they would previously have had to contract out. The developer and user might be the same person, or on the same small team. In the case of entities (agencies, groups, teams) concerned with geographic information, this breakdown of boundaries between user and developer facilitates the development of software applications that instantiate novel spatial and geographic metaphors.

The ability to construct such applications depends not only on the flexibilityand ease of use of development environments but also on the availability of reusable software components and on the scale and purpose of the application. In my work, I introduced the notion of a geographic information application, built up using a library of such components, to contrast with the current "toolkit" model of a fully-featured geographic information system.

As part of my research, I constructed a geographic information application that modeled the locational behavior of the objects of interest to cadastral cartographers -- parcels, monuments, property points, etc. Thus, if we take my experience as a guide, it is possible to develop a model of novel geographic and spatial metaphors in a running application, and it is possible that this development need not rely on vendors of full-fledged GIS software.

In naming the category of technologies of metaphor, and in identifying geographic information applications as a member of that category, I aim to enable the promotion of a cartography/geographic information science consonant with Lipietz's "alternative" societal paradigm. One aspect of the alternative societal paradigm is the advancement into dialog of a pluralism of metaphor. Or, to put it another way: the mobilization of technologies of metaphor in the field of geographic information may be empowering to users/developers seeking to model and display their own metaphors of space and place, and I see this as beneficial to a democratic society.

Various kinds of social entities -- whether agencies within local government seeking to fulfill their mandates, neighborhood groups confronting toxic waste, indigenous groups describing traditional sites, or cultural minorities defining their territory -- need to tell their story about the space and place that matters to them. And they often need to tell their story through the medium of maps. When it happens that the terms and categories these groups use in their descriptions do not fit easily into the frameworks available in the conveying medium, it diminishes their power over the space and place that is their concern. Their power is augmented by the ability to develop models (and visual displays that portray those models) that capture those terms and categories.

I see my research direction following two concurrent paths. First, I intend to refine the prototype application I have developed so that it may ultimately be deployed in a working environment, partly as a test of the practicality of the model, and partly to track how such a technology in a local government context will impact (and will be impacted by) the conduct and practice of handling geographic information. Secondly, I would like to develop other geographic information applications, using other spatial, locational, and geographic metaphors, partly to explore how well o-o software development will model these metaphors, and partly to gain more clarity on whether and to what extent such a technology can be accessible to, and usable as a development tool, by the end users that live by differing spatial metaphors.

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Geographic Visualization and the Making of a Marginal Landscape

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Geographers have been confronted with an extraordinary range of new technologies for representing, analyzing, presenting, and disseminating geographic information: geographical information systems, multimedia, hypermedia, mapping, image processing, and the World Wide Web to name a few. These technologies present practical, methodological, and theoretical challenges to geographers. Yet the complex and multifaceted nature of new geographic information technologies is matched by the complex and multifaceted nature of geography itself. Geography is a discipline of strong contrasts: physical geography and human geography, and the various, sometimes incommensurable approaches to geography - positivism, marxism, realism, humanism, postmodernism, etc. Thus we have a broad array of new geographic information technologies, and a complex and multifaceted geography: It is the substantive relationship between the two which underpins the research reported in this presentation.

My background in cartographic and information design has shaped my research interests in issues of visual representation within the context of geographic information technologies. But I am also a geographer with interests in landscape, regional, social, and historical geography, and I am interested in examining the relations between my geographical interests and new geographic information technologies. Given this context, my presentation consists of three interrelated parts.

First, I examine the historical relations between cartography and geography. I suggest that geographers have continually raised questions as to how maps and other visual methods relate to theoretical and conceptual differences in geography - questions which have not been adequately addressed by cartographers. I relate these critiques of maps and mapping by geographers to current critiques of mapping and geographical information systems, critiques which suggest that particular theoretical and philosophical perspectives have dominated cartography, GIS, and geographic visualization, while others have been left relatively unexamined.

Second, I will present a conceptualization of geographic visualization that expands upon cartography s traditional focus on the map and communication while more clearly linking geographic visualization to conceptual and theoretical issues in geography. In particular, I examine the range of visual forms which are used by geographers, and the explicit relations among various visual forms and text within the context of hypermedia. I suggest that the characteristics of hypermedia are amenable to current theoretical and methodological issues in landscape, regional, and social geography.

Third, I will present an example of how this general conceptualization of geographic visualization works in practice, using a case study of the human and environmental aspects of derelict and marginal landscapes and the people who inhabit these places. My interest is in examining how marginal and derelict landscapes are produced and utilized. I use visualization methods, broadly defined, to address methodological issues posed by geographers such as Andrew Sayer, Edward Soja, and Alan Pred.

My case study examines the making of a particular marginal landscape in north-central Pennsylvania, an area currently known as the Quehanna Wild Area. My visual methodologies - guided by the theoretical and methodolological issues noted above - allow me to examine how a particular marginal place is made over time and space, at different scales of incorporation, including the role of different groups of people and different projects in this process. My study reveals the pulsating incorporation and disincorporation from broader economic and social and cultural geographies, confounding the assumption that places are marginal because they are not incorporated and suggesting that they are marginal because they are incorporated. This raises the issue of the utilization of such marginal places: who is interested in holes in the map and what happens in such places? I examine the role of marginalized populations in my case study; human reactions to abandonment, and the use of marginalized places as a form of social control of marginalized populations. This suggests that marginal and derelict landscapes are not merely the passive outcome of human activity; they are actively engaged in cultural, economic and social processes. My visualization methodologies, including a range of visual forms derived and constructed with GIS, image processing, mapping, and hypermedia software, provide a means of examining the complex spatial and temporal context of marginalized places and people. My interest is in exploring how geographic understanding can guide and shape research on visualization design and methods: how geography can shape visualization. At the same time, I am interested in how visual methods can guide and shape research in geography: how visual methods can shape geography.

Future Research Plans

I plan to develop several aspects of the research described in the position statement. I will continue to examine the relations between different theoretical and philosophical approaches to geography and visual representation, geographical information systems, and other geographic information technologies. This research will include both theoretical and applied studies, particularly in my geographic areas of interest (cultural, historical, social, landscape). I am particularly interested in why certain approaches to geography seem to avoid the use of visual representation, mapping, GIS, and other geographic information technologies. In addition, I am interested in examining the relations between representational forms (text, images, maps, diagrams, graphs) in the context of GIS, multimedia, and hypermedia, again in relation to geography and geographic research. Finally, I plan to pursue geographic research projects (using geographic information technologies) on marginalized people and landscapes: the spatial characteristics and movement of marginal people (prisoners, boot camps, the removal of recovering drug

addicts and welfare recipients from cities to small towns, and the characteristics of people who live in declining and marginal regions), causes and utilization of marginal places, heritage tourism and industrial heritage in marginalized places, the geography of garbage and toxic waste and marginal places as dumping grounds, spectacular activities in marginal places (such as the Atomic Energy Commissions plans to use nuclear explosions for civil engineering projects in the 1960s), etc. I am interested in how geographic information technologies relate to all these topics. I also plan to examine the use of such technologies for community empowerment and community information systems, particularly in marginal, declining, and stressed areas and regions.

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Introduction

Over the past twenty years, advances in digital cartography and geographic information systems (GIS) have made mapping and spatial analysis accessible not only to geographers and other spatial scientists, but also to society in general. GISs, which are computer-based methods for encoding, storing, analyzing, and representing (mapping) spatial data, now can be found in all levels of government and the private sector. Locally for instance, Hennepin County government maintains a state-of-the-art GIS for property records, criminal analysis, and parks/recreation, while Dakota Electric has developed a detailed spatial database for maintaining public utility records. Concomitantly, the application of geographic information systems to assess environmental and technological risk is increasing. One can find examples of GIS used in assessing the risk from air toxics, monitoring the quality of groundwater, analyzing the human response to earthquakes, and wildfire management planning. In most instances, while the development of a database focusing on the actual risk is adequate, or even quite detailed, the information on human activity--what may be called the basic geodemographics--is poorly developed. Accounting for societal needs must become an integral component of GIS in the domain of risk analysis.

Public policy, geodemographics, and risk assessment

Emergency Planning and Community Right-To-Know

The Emergency Planning and Community Right to Know Act of 1986 establishes requirements for Federal, State, and local governments and industry regarding emergency planning and Community Right-to-Know" reporting on hazardous and toxic chemicals. The purpose of the Community Right-to-Know provision is to help increase the public's knowledge of and access to information on the presence of hazardous chemicals in their communities and releases of these chemicals into the environment. States and communities will, with these data available, be better able to improve chemical safety and protect public health. The Emergency Planning and Community Right-to-Know Act (SARA Title III) has four components: emergency planning, emergency release notification, community Right-to-Know reporting requirements, and toxic chemical release inventory.

Emergency Planning

The emergency planning legislation is designed to promote State and local governments' emergency response and preparedness capabilities through both better coordination and planning. At the state level, The Emergency Planning and Community Right-to-Know Act requires the Governor of each state to create a State Emergency Response Commission (SERC). According to the Title III Fact Sheet, the SERCs include individuals from a variety of public agencies, including those that deal with the environment, natural resources, emergency services, public health, occupational safety, and transportation. It is also the responsibility of the SERC in each state to appoint local emergency planning districts and Local Emergency Planning Committees (LEPC) for each district. Most often, the planning districts are established at the county level although some substate planning districts have been created. Among other tasks, the SERC is responsible for establishing procedures for receiving and processing public requests for SARA Title III data. The LEPC for each district normally includes a mixture of individuals from the following organizations: elected state and local government, police, firefighters, civil defense, public health, environmental, hospitals, transportation, representatives of facilities, community groups, the media. As of October 17th, 1988, the LEPC was responsible for creating an emergency response plan. According to the Title III Fact Sheet, this plan must include the following:

- identify facilities and transportation routes of extremely hazardous substances.

- describe emergency response procedures, on-site and off-site

- designate a community coordinator and facility coordinate to implement the plan

- outline emergency notification procedures

- describe methods for determining the occurrence of release and the probable affected area and population

- describe community and industry emergency equipment and facilities and identify the persons responsible for them

- outline evacuation plans

- describe a training program for emergency response personnel

- present methods and schedules for exercising emergency response plans.

This emergency response plan, initially reviewed by the SERC, is also reviewed annually by the LEPC. It should be noted that the LEPCs first area of concern is with the threshold planning quantities of the 360 extremely hazardous substances published in the Federal Register. The list and threshold planning

quantities are based on toxicity, reactivity, volatility, dispersability, combustibility, or flammability of the substance.

Risk analysis

We will detail a project that uses geographic information systems (GIS) to analyze technological risk in the Twin Cities area. First, we describe a risk assessment for the Twin Cities area that involves an analysis of the TRI (toxic release inventory) data, gathered under the Community Right To Know legislation, and basic geodemographic characteristics of the Twin Cities, including race, income, and housing data using GIS. This analytical stage will attempt to identify those regions of the Twin Cities most susceptible to an air-borne toxic release. It will be necessary, of course, to also identify regions of the metro area where significant percentages of lower income and minority groups reside. Such analysis will attempt to identify regions within the Twin Cities that are, according to Massey and Denton, hypersegregated, using measures such as unevenness in the distribution of the minority within the total population, residential isolation of minorities from non-minorities, the degree of clustering of minorities in a single area, the degree to which minorities live near the central business district, and the concentration of minorities into densely-populated neighborhoods. In the few existing studies, including those by McMaster (1991), and Burke (1993), strong spatial associations were discovered between the location of both minority and lower income populations and the location of hazardous materials. This condition has been labeled by some environmental racism, although the term implies a planned positioning of environmental hazards, which may not always be valid. The McMaster study, using grid- based GIS analysis and modeling, found strong correlations amongst minority (including African-American, Asian, and Hispanic) and hazardous materials sites in Santa Monica, California. Applying tract-level analysis of 1990 Los Angeles census data Burke, likewise, found associations amongst TRI (Toxic Release Inventory) sites, lower income groups, and minorities. Both studies were preliminary, and much work remains in identifying logical methods, for the identification of, and subsequent mitigation of this problem.

Included in the analysis will be day-care centers, schools, and other institutions likely to house sensitive populations. In order to account for varying meteorological conditions, our plans are also to include a Gaussian plume-dispersion model in this analysis that will provide the spatial distribution of given TRI substances, in parts per million, given specific wind speed, direction and chemical type/amount. The end result of this project will be the development of a risk model for the Twin Cities, a spatial analysis of sensitive and minority populations related to this risk, and an attempt to articulate the degree of environmental in justice that results from the storage and manufacture of hazardous materials. An ancillary component of this study will complete a geodemographic analysis at a variety of scales--block, census tract, and neighborhood--to determine the effect of resolution on risk assessment. The measures for determining the aforementioned hypersegregated regions of a city, for instance, are not consistent as one moves from the more regional tract-level resolution to the finer block-level. What effect does this

have on risk correlation? Is there an optimal resolution for such urban analysis (e.g., Are block-level data simply too noisy for such studies?), and what is the effect of mixing both different geometries--point, line, and areal data--and different resolutions. Such research falls within what is called the modifiable areal unit problem, or MAUP. The careful identification of such segregated populations is, of course, crucial for including societal concerns in risk studies.

Building on the results from this GIS-based risk analysis, the issue "risk perception" will be addressed in a subsequent study. All individuals carry preconceived ideas of risk to hazardous materials. Some are not concerned with purchasing a home several blocks from a TRI site; others, because of concerns about the potential toxicity, position themselves great distances from such sites. It should be noted that the same spatial decisions are made regarding other societal risks/problems, such as crime, flooding, and airport noise. We intend to build, starting at the neighborhood level, a perceived risk surface to technological hazards for the Twin Cities. How does this compare with the actual--derived in stage one-- surface? How does such a perceived surface affect spatial decision making with regard to hazardous materials? Are there cultural/ethnic differences in the perception of risk? Most importantly, how can perceived, in contrast to actual, risk be represented within a GIS (visualized)? The GIS community can not assume that an actual distribution is always the best for estimating societal behavior; most individuals make spatial decisions based on their perception of risk--the mental map as articulated in the geographical literature.

Contribution to discipline

A growing area of concern in GIS deals with its relationship with society, including issues of privacy, legal ownership of data, ethical considerations, and how alternative views of social space can be represented in what are, admittedly, almost exclusively Euclidean-based systems. Through addressing both a series of conceptual and empirical questions, we feel the research design proposed here could provide the framework for other geographical studies that address GIS and society issues (mixing regional and community levels of analysis). Thus far, most of the studies in this area have been written either from a critical social theory perspective (skeptical of the potential use of GIS) or from the GIS specialists standpoint (overly optimistic about the potential for GIS). This study attempts to bridge these two views by looking at both the spatial data/analysis side of GIS, as well as several case studies that address the actual impact of GIS on a societal concern: the actual and potential risk to hazardous materials in the Twin Cities.

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In assessing environmental hazards, one of the least researched areas to date has been the ways in which participatory democratic organizations (hereinafter referred to as grassroots organizations) make use of GIS-based information in their attempts to identify, inventory, and deal with environmental hazards, either existing or proposed. Making use of the GIS of TRI sites for selected Twin Cities areas developed by Bob McMaster et al., we propose to examine the different ways that grassroots organizations utilize (or don t utilize) available information in dealing with environmental hazards.

The research problem is complicated by the fact that we need to deal with at least two major types of grassroots organizations: environmental movements (which may have more general, and less locality-based interests); and neighborhood organizations and other urban social movements whose thematic interests may be much broader than those of environmental groups, but whose level of spatial organization tends to be more parochial. In addition, these different types of groups may differ from one another in having different levels of access to GIS-based information (or the technology and skill needed to interpret it). Thus, we can conceptualize our proposed research as examining a four-cell matrix, using comparative case studies to look at organizations with broad environmental agendas or with more neighborhood-based concerns, each of which may have high or low levels of access to GIS.

As we examine our case studies, based on the reactions of community and environmental groups to TRI data in GIS format, there are four types of questions that we wish to ask. First, how available and appropriate is GIS information for grassroots organizations? Second, what impact does access to GIS-based information have on the participation and effectiveness of grassroots organizations in policy discussions and policy making? Third, does utilization of GIS affect the mission and outlook of grassroots groups? And fourth, what difference does availability and utilization of GIS-based information make for the wide variety of different groups affected by environmental hazards?

The first stage of this research builds on the GIS work being carried out under the I-19 initiative by Bob McMaster to establish the Twin Cities TRI landscape, and analyze the local geodemographic settings within which TRI sites exist. For this research project, we will choose groups from areas with different geodemographic profiles -- poor and rich, central city and suburban, predominantly white and largely minority.

The second stage of this research examines how the different types of community groups utilize (or ignore) the TRI data. We will carry out intensive case-study analysis of a limited number of grassroots organizations dealing with environmental hazards. For groups already utilizing GIS technology, we will examine the following questions:

For what types of activities or problems is GIS utilized?

What kinds of information are available to the different grassroots organizations, and from which sources?

1. What perceptions exist about the usefulness of GIS-based information among group members?

2. What kinds of information are not found in standard GIS sources? Are they available elsewhere?

3. To whom within the organizations is GIS-based information made available, and in what ways?

4. How do GIS technology and information influence the mission and activities of these grassroots organizations?

5. How has GIS-based information changed the participation of grassroots groups in policy discussions and policy-making?

For groups that do not yet have access to GIS technology or information, a different set of questions can be posed:

What are the group's perceptions of environmental hazard, andwhat kinds of information do they consider important in considering environmental hazards?

How do group perceptions differ from available GIS-based information?

1. Given the group's perceptions and concerns, is the available GIS-based information useful?

What kinds of information are not included in GIS-based sources that might make them more useful to these groups?

1. How can such missing information be integrated into GIS so that the systems will be useful to these groups?

We can envision an experiment in which groups that previously did not use GIS are provided with access and data. We hypothesize that the following stages will occur:

1. Initial frustration because of the complexity of the technology and an imperfect match with community ways of understanding the problem.

2. Tendency towards convergence of community views with those prioritized within the GIS.

3. Increased group influence on the decision-making process, in part because greater expertise with technology allows for more expert presentations, and in part because of a convergence in views resulting from increased utilization of common information bases and technologies.

Finally, we think it important to assess who gains and loses from a process in which grassroots organizations utilize GIS. What are the consequences for the larger community? For group participants? For those creating the GIS being used? Is it possible that community groups will become divided around issues of access and/or familiarity with GIS versus distrust or technological unease? Will some of the richness and diversity of opinions within larger communities be reduced to a basic set of issues and approaches that can more easily be modeled using GIS? (This problem is endemic to all forms of technical planning and not just the application of GIS-based information to environmental hazards research.)

Clearly, these research questions don t get at all of the societal divisions that could affect how grassroots organizations utilize GIS-based information. But studies of the effects of race, gender, and class, as well as the interrelationships among these variables (and their spatial distributions) seem more appropriate as follow-on studies, after this more basic research has been accomplished.

Given the complexity of issues that intersect with the use of GIS-based information by grassroots organizations, comments and suggestions from other I-19 researchers are particularly solicited. We hope that the issues we ve outlined in this proposal will stimulate a lively discussion, both social theoretical and methodological.

Nature, Society, and Experience: *Their Roles in the*
Construction of Cognitive Representations of Space

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A scientific view of reality would assert that the nature of the world lies in properties that are inherent in the world and that exist independent of the observer; such properties can be observed using objective procedures. In contrast, many social theorists claim that reality is socially constructed. There is also a third major perspective on reality: many cognitive scientists believe that the realities that people experience are a product of interactions between human bodies and senses on one hand, and the human environment on the other. While not incompatible, these three views put different emphases on the relative importance that scientific 'reality', cognitive processes, and social interactions have in shaping human behavior.

The word 'representation' is used both in cognitive science and in social theory. In cognitive science, a representation is "a set of conventions about how to describe a set of things" (Winston, 1984, p. 21). Winston goes on: "A description makes use of the conventions of a representation to describe some particular things." Cognitive representations are formed by experience with an external world, and are subject to modification every time they are 'used' in cognition. Mental representations play a key role in top-down (schema-driven) interpretation of sensory inputs or memories. A model based on this is known as experiential realism (Lakoff, 1987; Mark and Frank, 1996). In social theory, however, the concept of representation is less well defined, but often seems concerned with distortions.

Even if experiential realism is 'correct', it is obvious that other people, and artifacts constructed by people, form a major part of the environments in which individual human cognitive representations normally develop. Learning a natural language is a social experience, and since language and concepts are so closely related, language may play a key role in promoting convergence between the cognitive and social views of the construction of reality. Of particular interest in geography is the role of artifacts and behaviors that represent spatial information, namely maps, diagrams, and verbal descriptions for wayfinding and navigation.

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I have initiated a study of the cartographic labor process at a major U.S. mapping agency. While this research is not explicitly focused on the implications of a gendered labor process, it is my intent to explore as an integral component of the study the empirical and theoretical implications, as well as the embedded contradictions of the public production of cartographic representations within a male-dominant social system.

Map production, organized during the 20th century as a scientific-technical manufacturing process utilizing photomechanical and optical techniques and producing analog products, has been (and continues to be) reorganized around digital map production in the context of a public/private institutional matrix. The empirical component of the project mentioned above includes collecting the oral work histories of cartographers and managers that have been present during the period of analog-digital conversion (approximately 1970 - present) through the use of in-depth recorded interviews. My intent here is to develop a better understanding of the "professional trajectories" of individuals within a large mapping enterprise as they pass through the lens of technologically - driven restructuring. A special effort will be made to ensure that all groups represented within the agency during this transformation are included within this portion of the study. The principal concern of this research will be to construct a social history of the analog-digital transformation in a particular context that is primarily sensitive to skills, techniques, and the interactions between workers, managers, and the products of their labors.

A second area of inquiry within this study will involve the collection and analysis of summary personnel data, as well as internal and public agency documents related to technological restructuring for this agency over the past several decades. This is intended to provide a broader perspective on institutional changes that have taken place and allow the construction of an institutional context relative to the narratives mentioned above. It should also provide detailed numerical information that will shed light on the degree of "male-dominance" within this particular agency over the past few decades, and will allow an independent analysis of the efficacy of historical employment policies and practices directed toward increasing the participation of under-represented population groups such as women, African-Americans, or Hispanics.

The consequences of the transformation from analog to digital map production for cartographers and managers is not well understood. The earlier configuration within the NMP placed cartographers within

narrowly defined specializations that were closely connected to the labor input needs of a largely photo-mechanical process. Following the onset of digital conversion, however, many of these highly skilled tasks (e.g. scribing, photo typesetting), became redundant or unnecessary to the new production system. In addition, the role of managers and workers in the digital production system has been transformed to meet the needs of the new technologies. Clearly the effects of recent technological change on cartographic tasks and skills are not simple or easily explained by reference to a single logic. Whether these changes (largely taking place over the last three decades) have fundamentally altered the basis for women's participation in cartography or GIS remains an open question. Women historically have participated in the production of cartographic representations only marginally (with some notable exceptions), however, in the past few decades increasing numbers of women have joined the ranks of cartographic workers, technicians, and managers. This change reflects employment gains made in other scientific-technical labor processes and may be the logical outcome of generally increasing female participation in the workforce. Since this has taken place concurrent with the reconfiguration of the labor process itself to meet the demands contingent on new technology, it will be difficult to link apparent change to causes.

Beyond the sheer numbers of women participating in the cartographic wage economy however, a deeper epistemological challenge remains. An evolving body of feminist writing has called into question the very ground upon which patriarchal or masculinist science stands, and has convincingly shown the ways that systems of thought within the natural sciences are shaped through reference to logics drawn from received notions about society, culture, the division of labor, and inquiry (e.g. Haraway 1989; 1991; Rose 1992; Deutsche 1991; Gregory 1994). Traditional science is bound to the notion of the "master subject" universally recognized as white, male, and bourgeois. Scientific practice in the natural and social sciences has engendered a "man's world" (in the sense of claims to truth which weave the intellectual fabric of patriarchy and legitimate gender-based exploitation), and the practices themselves are the product of contingent rationalization of methodologies which have produced instrumentally useful results.

In cartography and GIS, technique has become codified in a similar fashion, and the claims to truth produced are often spectacular in their utility. Yet the near-universal acceptance of the cartesian logic embodied in the map may close out other ways of knowing the world, ways forgotten or not yet discovered, and feminist cartographers are necessarily forced to embrace a gendered system of thought, practice, and representation as they participate in the world of work. There are at least two possible ways forward. First, open our conception of the strict boundaries of cartography and GIS to include the possibility of infusion from other representations not necessarily derived from cartesian models of three-dimensional space (visual art? poetry? song? political thought and speech?). Second, we should encourage the subversion of existing technique and its practice toward the production of representations of space which challenge accepted notions of society, culture, economy, work, and the everyday (an obvious example from recent disciplinary history would be time-geography and its application).

My current research holds relevance for the proposed initiative 19 principally in the first issue area of the call for participation. If explicit "logics" exist within current GIS practice they are at least in part determined, extended, or borrowed from the set of practices that evolved as cartography. So much GIS practice appears to be data dependent (imagine what the industry would look like without census data), and new digital cartographic data often spurs the development of new applications. It is crucial to understand the social relations of digital cartographic production as being the end product of centuries of contingent rationalization of scientific-industrial processes that have evolved alongside other gendered labor processes. The digital map, like the paper map before it, is inscribed with the power relations characteristic of the society which produced it - overwhelmingly reflecting the power of scientific rationalism - and the challenge will be to describe those relationships and their contingent articulation within the state. By situating the assumptions that ground cartographic technique (and its progeny GIS) within the context of gendered science and scientific-technical production systems perhaps we can open spaces for new forms of cartographic thought and practice and new ways of mapping the futures of women and men.

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When a firm or government agency uses a geographic information system to locate a facility that generates, stores, buries, or burns hazardous waste, local residents concerned about health and property values feel doubly threatened when they cannot readily interrogate the data or evaluate alternative sites. Despite public hearings and environmental regulations intended to address residents' concerns, lack of sophisticated tools and specialized knowledge would appear to place them at a distinct disadvantage. For this reason, social scientists promoting empowerment and fairness recommend giving project opponents access to a comparable GIS. Not surprisingly, GIS vendors and GIS educators endorse this strategy.

While logical and laudable, this approach is also short-sighted, if not condescending, in its assumption that the success of a grass-roots challenge depends upon access to techno-scientific weaponry. Strategies that view GIS access as the primary means of empowerment overlook the power of ridicule as a persuasive weapon that works well even when project opponents have a weak argument. Moreover, in the same way that ridicule can undermine an incomplete or otherwise flawed siting study, project opponents armed with a GIS but lacking the savvy to use the system appropriately become vulnerable to sarcastic attacks from site advocates and skeptical journalists. For opponents with access to a GIS, the most effective strategy might be to search for flaws rather than prepare a complex, time-consuming GIS-based rebuttal, which project supporters can cross-examine and ridicule.

Two Case Studies

Two case studies from New York State illustrate the power and importance of ridicule as a grass-roots defense.

A chapter in DRAWING THE LINE: TALES OF MAPS AND CARTOCONTROVERSY focuses on the first example, in which a well-funded five-member commission used a GIS to locate a statewide low-level radioactive disposal facility (Monmonier 1995). Acting on vague advice from the U.S. Nuclear Regulatory Commission, the siting commission adopted an allegedly objective multi-stage top-down siting process, in which GIS was the principal analytical tool in the early stages of exclusionary screening, candidate-area selection, and potential-site identification. Because of public furor over the chosen candidate areas and

potential sites, the siting process never advanced to its later stages. Opponents used ridicule to win statewide media coverage, enlist the support of an influential senator, and publicly embarrass the siting commission on several occasions, most notably by publicizing a U.S. General Accounting Office report titled "Nuclear Waste: New York's Adherence to Site Selection Procedures Is Unclear" (U.S. GAO 1992).

The siting commission's wounds, ultimately fatal, were partly self-inflicted. Lacking expertise in GIS, the commission accepted an out-of-state contractor's recommendation of a complex screening process based on nested grids of square-mile and 40-acre cells and a scoring and weighting scheme involving several dozen "exclusionary" and "preference" factors, a number of which proved counterintuitive or irrelevant. When county officials and citizens groups challenged the siting commission in newsletters and press releases as well as at public hearings, the commission's maps "electronic and paper" became an important target. After a near riot in one of the two counties with potential sites, the governor halted the siting process, and the state legislature not only imposed numerous restrictions, including guaranteed public access to the commission's GIS, but also called for an unbiased external review. In 1993, the National Academy of Sciences initiated a three-year review of the siting process, and in 1995, embarrassed again by issues resurrected during the NAS hearings, the legislature shut down the commission altogether.

My second example concerns the Onondaga County Resource Recovery Agency's application to open a solid-waste landfill for ash from its new trash-burning electric power plant. Ridicule played a comparatively subtle role in this controversy. Local opponents of the landfill raised doubts about the accuracy of measurements based on soil survey data and won an adjudicatory proceeding that delayed the siting process an additional year. I participated in the permit hearing as an expert witness hired by OCRRA to defend its consultants' measurement of the proportion of prime agricultural soils on the site. This measurement was important because OCRRA, a public agency, exercised its right of eminent domain when one of several property owners refused to sell. The reluctant seller's farm was in a special tax district that conferred a lower rate on agricultural land, and state law prohibits the use of eminent domain in an agricultural district when "group one and group two soils," as defined by the state's land classification system, predominate on the site. Various measurements by OCRRA's consultants as well as by staff of the New York State Department of Environmental Conservation indicated that prime farmland occupied between 38 and 44 percent of the site, considerably and consistently less than 50 percent limit set by the "Agricultural Exclusion." Nonetheless, the Town of Van Buren and PURE (People United for a Rural Environment), the "intervenors" in the permit application, made a valiant attempt to discredit the techniques used for measuring area, the use of a CAD/CAM system to integrate the soils map with a property survey, and the soil survey's treatment of inclusions and use of unrectified aerial photography as a base map. In eight days of hearings, spread over three months, the intervenors repeatedly asserted that the "margin of error inherent in the soil survey" was too great to permit a reliable determination of predominance. That the administrative law judge assigned to the hearings allowed such a lengthy and

costly proceeding reflects New York's commitment to open government and fairness as well as environmental regulations that are silent or imprecise about the use and quality of spatial data.

In the sense that a CAD/CAM system with multiple layers of geographic data is a GIS, the intervenors had their own GIS (PURE's representative, a registered architect, was a CAD/CAM instructor at a local community college). Early in the hearings, during a discovery phase in which parties were asked to present any measurements they might later introduce, PURE circulated a crude sensitivity analysis that assumed the true boundaries of polygons around agricultural soils were on the outside of cartographic lines printed in the soil survey report. But PURE wisely chose not to introduce its conceptually frail representation in formal testimony: this overreachingly favorable interpretation of the soils maps could not raise the proportion of better agricultural soils above 50.3 percent, and the crude digitized polygons were themselves vulnerable to ridicule.

Research Goals and Reserach Questions

Several factors account for the effectiveness of ridicule in a counter-offensive against GIS: bureaucrats fear embarrassment almost as much as indictments and budget cuts; citizens enjoy seeing public officials humbled if not humiliated; the news media eagerly confuse uncertainty with ignorance; and the data employed in geographic analysis are seldom completely suitable for the questions GIS users ask. The process of siting an objectionable facility is long and complicated, and public hearings at various stages as well as the option of judicial appeal offer numerous opportunities for counter-attack. And because options to purchase expire and political support erodes easily, a string of delays can be as successful as the denial of a permit.

Study of locational conflict involving disadvantaged populations must address the vulnerability of GIS analyses to sarcastic and scornful humor. Fuller understanding of this vulnerability should lead to a fairer, demonstrably more accurate and ethical use of GIS as tool of compromise, not conquest. To develop this understanding, social scientists must rely largely on case studies that include interviews with the people involved as well as an examination of raw data, permit applications, relevant legislation and administrative regulations, transcripts of hearings, media accounts, and press releases and other representations by supporters and opponents. Informed by work on GIS standards and data quality as well as by insightful writings on humor and sarcasm, these case studies might address five sets of research questions:

1. Why and how are the results of GIS-based siting analyses vulnerable to ridicule? How does lack of public understanding make advanced technology vulnerable to misuse and ridicule? When might an appropriate use of GIS be vulnerable to ridicule? What relevant insights exist in philosophical examinations of humor and ridicule?

2. In what ways can ridicule empower project opponents? And in what ways might overuse of ridicule diminish their effectiveness? What particular advantages does ridicule enjoy at public hearings and in the media? In what ways are project opponents themselves vulnerable to ridicule?

3. How do legal and administrative requirements (which can vary from state to state as well as with type of facility) enhance or reduce the power of ridicule?

4. How can advocates for disadvantaged populations most effectively alert potential victims to the vulnerability of GIS? How might knowledgeable advocates most effectively advise them on detecting flaws and cross-examining GIS personnel?

5. How can project supporters using GIS protect themselves and their constituencies from ridicule? Can an expedient analysis based on temporally and geometrically incompatible data be successfully defended?

Plans for Continued Research

Aside from work in progress on cartographic risk communication and the use of environmental modeling, my plans for continued research on issues of GIS and society are admittedly vague. Because close study of GIS in land-use and other controversies has been highly informative, I remain attuned to local and regional conflicts, including the current National Academy of Sciences review of New York State's low-level radioactive waste siting work. (The NAS study is under the auspices of the nuclear safety arm of the NAS/NRC; no members of the panel are experts in either GIS or spatial analysis, and most members have employment or consulting ties to the nuclear industry.) I am also interested in the use of GIS in emergency management, and have been informally exploring disparities among New York counties in the use of spatial modeling tools. A possible future project is a citizen's guide to GIS and spatial data in environmental analysis.

This strategy, which at times might pass for "participant observation," depends on access to participants, documents, and public events such as hearings, trials, and legislative sessions. Although news reports contain useful information (some facts and opinions as well as the biases of news gathering organizations) and many public hearings are now videotaped, local access provides valuable opportunities for interviewing participants; for observing their use of maps, graphics, and other visual materials; and for collecting literature and insights not found in the public record. For this reason, what happens where I live or nearby will strongly affect my research and writing.

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My research interests since 1989 have emphasized the implementation of geographic information systems. I have discussed some of the issues outlined in your Call for Participation in my publications, which include *Managing GIS* (co-authored with Jeffrey Pinto). Specifically, my research has addressed themes under two separate conceptual issues of your Call for Participation: (2) how the proliferation of GIS data bases and differential access to spatial data bases influences the abilities of different social groups to utilize information for their own empowerment and (4) the possibilities and limitations of using GIS as a participatory conflict resolution tool.

For example, "GIS in a Democratic Society" (Chapter 11 in *Managing GIS*) suggests that GIS in a democracy presents both opportunities and problems to citizens. As the technology becomes more powerful, user friendly, and affordable, it becomes more readily available to a wider range of individuals and interest groups than ever before. This increased availability of GIS technology is valuable in a democracy because it holds the promise of including more voices in important policy debates at all levels of government. As with any technology, problems (technical, social, and legal) are bound to arise as the technology comes into wider use. Initially, the concentration of knowledge about GISs in the hands of technical experts, rather than policy experts, is cause for concern. Ultimately, ensuring that policy experts gain knowledge about the capabilities and limitations of GIS is equally important. Just as important, however, is assuring that ordinary people with a good knowledge and understanding of their problems also have a role in making policy that affects them.

Another publication (The Hidden GIS Technocracy, which appeared in *Cartography and GIS,* vol. 22, no. 1, 1995, pp. 78-83), begins with the premise that the proliferation of geographic information systems, especially those for PCs, seems to be a democratizing, counter-technocracy trend, but goes hand-in-hand with a centralization of the geographic modeling programming that underpins the GIS. These paradoxical trends give the illusion of growing democratization of GIS technology, while in reality, there is a growing danger of the rise of a hidden GIS technocracy, owing primarily to the lack of recognition that such a technocracy exists. While the decentralization of the technology is likely to prevent any major widespread cataclysms, individual organizations implementing a GIS may experience problems caused by the implementation of geographic modeling programs that may be inappropriate to their needs. The remedy for such problems begins with awareness of the hidden technocracy and of the potential for trouble. One way to increase awareness is to promote the use of lineage information for the geographical models

embedded in geographic information systems in the same way that the GIS community has pressed for lineage information on databases.

I am currently working on a research project funded under the "Research Planning Grant" program of the National Science Foundation. My project, entitled "Spatial Conflict in the Information Age," explores the claim made by some advocates of GIS that the systems can help to minimize conflicts over land use by providing more and better (more accurate) information about the subject of the conflict. I argue that this claim overlooks an important source of conflict: the underlying value differences represented by conflicting parties. Furthermore, I hypothesize that GIS will tend initially to increase, rather than decrease, conflict, since geographic information and analyses made possible by GIS can be used selectively by conflicting parties to support their positions. However, I view this conflict as a positive feature in a democracy, because it represents open dialogue concerning differences of opinion that must be fully explored as a precondition for acceptable public policy resolution.

The logic behind my suggestion that GIS will tend to increase conflict lies in research that identifies two sources of conflict: disagreement on facts (cognitive conflict) and disagreement regarding values (interest conflict). While GIS can influence facts in a particular conflict, by adding facts or presenting facts in a variety of ways, there is no reason to expect that the technology alone can or will do anything to mesh competing values. Value conflict, therefore will remain, regardless of the amount of information gathered to resolve it. At the same time, the greater quantity of information that GIS will make possible will very likely increase the number of "facts" that can then become the basis for further conflict.

This situation, however, points to another trend: the growing use of GIS in the public policy arena. Public officials have used GIS both to allocate resources as well as to examine specific public policies. In short, GIS has become embedded in both the process and outcomes of public policy. This trend warrants attention, and suggests a growing need to examine the relationship between public policy processes and outcomes, and to assess the ability of GIS to serve as a tool in developing public policies whose processes and outcomes meet with general public approval. Underlying this exploration is a recognition that even when citizens agree on specific public policy processes, the resulting outcomes may not be as satisfactory as anticipated. Within this context, the GIS is an especially valuable tool because of its potential to explore a variety of policy processes along with their outcomes in short time. Therefore, while (as suggested above) the proliferation of geographic information systems may increase conflict, the technology also provides means by which conflicting parties may seek common ground, and find a way to resolve their conflict.

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1. Introduction

It is useful to start by recognising the following situation. GIS is here to stay and really it matters little whether or not some geographers and social scientists do not like it much. Nevertheless, it is worrying that so many GIS applications are being performed in a socially naive manner by users who are largely oblivious to the potentially broader implications of what their technology is being or maybe used for. It is also worrying that in attempting to improve this neglect that so much ill-informed rubbish is being written about GIS, presumably by geographers and others who simply do not understand what it can and cannot reasonably be expected to do, or else are motivated by other concerns that result in them viewing GIS from perspectives that continually seek to question its legitimacy. Perhaps the principal problem with these critiques is that they contain an almost random mixture of trivia with a few very significant concerns but without much or any distinction in importance between them. It is almost as if the act of being critical will somehow, magically doom, GIS to the same oblivion that quantitative geography was apparently dispatched to a quarter of a century earlier.

It is useful to recognise that in excess of 90% of all GIS applications, maybe even 99.9%, are of no significant consequence to people and society. They involve applications that are concerned with the management of the physical infrastructure; such as those involving drains, wires, pipes, parcels of land, and roads. The vast majority of all GIS applications involve little more than a digital replacement for various large scale paper map making, recording, and handling industries. The problems with GIS that are of broader relevance to society lie elsewhere. In fact it might be useful to restructure the current critiques to focus on the role of GIS in three different domains which are enumerated as follows:

(1) the wider role of GIS in ongoing IT developments affecting the whole of society with the emergence of IT States;

(2) the nature of GIS as a database technology being used to represent information about people; and

(3) the use of GIS in spatial decision support applications that impact on people.

This threefold categorisation offers a potentially useful rationalisation of the various debates about GIS and society.

2. The wider role of GIS in ongoing IT developments affecting the whole of society with the emergence   of IT States

GIS adds an important and significant new dimension to many IT developments. However, what is the vital contribution that GIS is making to the continued development and eventual appearance of the IT State? Certainly, in most countries of the world, there are major changes underway in IT. When viewed in isolation these changes often appear to be mundane and fairly harmless technologies; for example, fibre optic cabling of homes, the gradual integration of multimedia technologies, and the falling cost of hardware permitting its use in an increasing number of domestic products. However, when these separate developments are viewed or linked together then a very different picture emerges with a unique potential for both good and bad on a scale and at a level never before encountered. Openshaw (1992) noted that "Too many people are ignorant of what is now possible and have no concept of any need to develop control systems designed to preclude misuse. The few exceptions form an information elite who could well become the dictators of the information age. Modern IT can indeed be used to strengthen and improve representational democracy but it also provides the basis for the most powerful and effective forms of 'people control' of the sort never before seen in history" (p 104). He outlined a five stage model of IT development in which GIS occurs in every stage:

Stage 1:   gradual computerisation of everything over a 50 year period including the cartographic industry and the ability to add locational references to personal data;

Stage 2:   distributed computing and open systems enable the linkage of historically separate systems whilst in GIS the development of data standards allowing ease of data transfer;

Stage 3:   expansion down to the domestic level and covering all aspects of life as databases become broader in coverage so the value added by geographic file linkage mechanisms becomes significant;

Stage 4:   construction of systems design to provide an improvement in well being and public good and it can be argued that automated exploratory spatial

analysis tools have a role to play in monitoring GIS databases for patterns, relationships, and the detection of anomalies which might be "useful";

Stage 5: potentially malevolent applications that could infringe civil liberties and human rights involving people surveillance and ultimately people control systems in which the ability to track movements in space is one of the key component technologies; and

Stage 6: an ultimate end state in which regulated, integrated, people management and control systems extend into all areas of existence and become a modern necessity in order to survive, perhaps following one or other major catastrophes.

The stages overlap and maybe Stage 3 has already been reached with aspects of Stages 4 and 5 becoming evident. The driving force is that of a continued and still increasing process of technological change and development, combined with the desire of governments, businesses, and people to survive. In IT terms we are still in a state of transition to an information state and GIS is one of the key component technologies but it is not the only or even the prime one. Yet if GIS did not already exist then it would, sooner or later, have been invented because it is so obvious and constitutes a key infrastructure resource. It is, therefore, unavoidable and inevitable that sooner or later GIS will become an important part of the set of modern management tools available to States and big business. In an increasingly political unstable world with problems of ever increasing complexity, it is inevitably that countries will use whatever means are available to ensure their survival. The problems for society concern what to do about these IT developments (not all of which can be perceived), how it might be controlled, and how to erect barriers that will stop an information elite gaining power for themselves. At the same time how do we balance these concerns with the potential harm that neglect of the technology might engender; for instance a State that fails to gain maximum benefits from IT might well be considered to be committing another type of crime. Openshaw (1993, 1994) identifies various types of GIS and spatial analysis crime and argues that the deliberate non-use of available technologies is a crime of some sort but so too is its abuse and naive usage. Surveillance may well be considered an infringement of public freedoms and liberties but it might also save lives, reduce crime, and result in more efficient government. The really fundamental question is how to get the balance right, how to manage the systems to minimise potential abuse, and how to future proof the barriers so that they cannot easily be subverted.

GIS technologies constitute only a small part of a much bigger picture that is being driven by a virtually unstoppable process of technological change. An equilibrium state has not yet been reached. The problem is that end user appreciation of what is now possible is lagging far behind what is now feasible,

and what is now considered feasible is itself far behind what will soon become possible. At present, anarchy rules and history suggests that at times like these dictators often emerge!

3. The nature of GIS as a database technology used to represent information about people

At a more detailed technical level, concerns exist about the nature of the representations of people provided by current GIS data models. Some critics emphasise various weak aspects of GIS that most GIS users would consider to be self obvious; for example, that GIS is map based, that maps are not necessarily accurate nor objective representations of reality, maps reflect the value systems of the map makers and have a historical context, States for various usually innocent reasons often distort what are shown on maps, the current GIS data models do not necessarily provide a good representation of people rather than property and inanimate infrastructure, the technology is not evenly distributed, it is being used by the military and States to "target" various people and areas; and there are no real controls on its use. There is a danger that the users of GIS will be misled into thinking it is a totally objective technology that provides a value free, scientifically correct and rigorous view of the world; when there are all manner of possible theoretical and methodological problems that may sometimes matter. To some extent the problem is knowing how to separate the important issues from the irrelevant distractions.

There are other questions that can be linked to these concerns. In particular "Can there be a socio-economic GIS?" or "What needs to be done to existing GISs to improve their capabilities in handling data about people?" or "Is the concept of socio-economic GIS so ridden with contradictions that such a system could never be built?" or "In the IT age what sorts of socio-economic database system would be regarded as necessary if the problems with GIS and conventional technologies are to be avoided or reduced?" or "Can there be a qualitative version of GIS?". Its not too late to invent a new technology if there are good reasons for doing so. There are major developments underway in soft computing technologies that may be very relevant in developing new types of GIS orientated towards social rather than map spaces.

Certainly in GIS the conventional data cube approach is still alive and well and in one form or another underpins most of current database technologies. Computerisation of details about people ultimately reduces to measuring the presence or absence or amounts of predefined variables that can be data captured ideally without too much difficulty by automated means. The emphasis is still firmly on accessible and thus partial quantitative information with all the well known problems but the appearance of soft computing technologies able to capture, store, and analyse video and audio data expressed in a digital form should not be underestimated. In some ways it is fairly trivial to add a multimedia dimension to the spatial information database. Equally it is possible to imagine GIS technologies being applied to capture and represent much more of the invisible and less tangible domains of the cyberspace with or without a geo component to it.

It is an appropriate time to consider how to specify (and perhaps build) alternative systems rather than just moan endlessly about the problems associated with those that exist.

4. The use of GIS in spatial decision support applications that impact on people

There is a political economy and social context to many GIS applications that the non-sensitised end-user will probably never have noticed. Most spatial decision support applications of GIS involve attempting to change or tampering with the real-world. There is nearly always a set of benefits that are sought and a cost to be born in attempting to achieve them. The challenge for the spatial scientist has traditionally been how to develop improved technologies that will yield even 'better' results with the definition of 'betternness' being left to others. The challenge for the social scientist is to provide a means of using GIS, of discovering ways of debating with it in order to address at least some of the broader concerns associated with its use. GIS is often viewed as favouring the establishment, the powerful, and the rich whilst harming in various unmeasured ways the poor, those who lack access to the technology, and have no spatial information of their own. This view is of course highly simplified and there are counter examples whereby minority groups have used GIS as tools to criticise governments and big business; for example, Openshaw's (1986) critique of nuclear power siting and Openshaw et al's (1989) critique of radwaste site selection.

There is a fundamental inherent contradiction in examining the impact of spatial decision support systems. Is it better not to use an SDSS than it is to use one? For example, suppose two banks merge and 20% of the branch network is to close. Do you: (a) use a GIS with an embedded spatial network optimisation procedure that seeks to maximise network profitability by determining the 'best' branches to close? or (b) do you select branches to close so that access by social disadvantaged groups (who may contribute little to bank profits) are preserved; or (c) muddle through doing neither using pre-GIS technology. The dilemma is that whilst (a) may well allow the bank to prosper after downsizing and secure the continued employment of 80% of the staff, both (b) and (c) may result in a continuing crisis with further branch contractions and closures. Its not easy but if these broader social implications are to become important then some practical means needs to be developed to allow them to be articulated in a form the geoprocessing technologies can handle.

Likewise, governments presumably have a duty in managing society to use whatever information resources exist; for example, in resource allocation, detection of crime, and prevention of terrorism. The geographic linkage of personal data is clearly an important activity that has the potential for both good and harm. It is perhaps worrying that at present the very state agencies most likely to be interested and actively involved in violating the confidentiality of personal information are (a) exempt from whatever Data Protection legislation exists, and (b) they will always be exempt on state security grounds. By comparison what the commercial marketing research sector attempts to do is pathetic in scale, grossly exaggerated in terms of its surveillance capabilities, and usually of a poor quality. Yet its quite fashionable to criticise the

commercial sector whilst totally ignoring the security services. It is also fashionable for government departments, fearful of bad press publicity, to deliberately not-use key information resources at their disposal. In the UK there are many databases for which an undisputed public good imperative for analysis and use exists but with little attempt to either analyse or use the data; for example, monitoring of spatially reference mortality and morbidity data for anomalous patterns. Public expenditure is still being distributed using data which is at best 5 years out of date and can easily reach 12 years out of date.

There are clearly some important methodological problems that also need to be resolved. For example, what is a safe level of spatial aggregation for presenting data about persons? In the UK the confidentiality risks present by different levels of geography have yet to be quantified. Data are released in a form that may well be too safe and in the process become so damaged as to impair many of the subsequent applications of it. Methods are needed to optimise the statistical disclosure risks.

Another area to consider is how best to use GIS as an aid to democracy. How should GIS be used as a public debating device? If its use is one-sided then it is clearly unfair, so what procedures and what mechanisms are needed so that its use can be made fairer and available to all? Openshaw and Carver (1994) argued that the key here might be the development of decision explaining systems, and that maybe there should be a requirement on the users of GIS to provide systems that allow others to explore the alternatives, to interrogate the databases, and to test out their own scenarios. Of course this may amount to no more than a public relations exercise but the new technologies that allow decision makers to optimise their decisions should also be available to those who wish to debate and influence them. Maybe this will be easier in a public policy context rather than in commerce, except that even within organisations there is a need for informed debate and dissension. Perhaps the key aspect is to distribute the information and the GIS tools rather than concentrate it in the hands of very select groups.

The challenge is to identify mechanisms that will allow the end-users of the technology to at least understand the areas of concern in those applications where they matter most as distinct from those where they may not matter at all. If this is to work then the language used to communicate these concerns has to be understandable to the end-users and developers of GIS. There is also a need for illustrations to show that they matter, rather than being of purely academic interest.

5. Conclusions

The success and use of GIS on a global scale has proceeded with a minimal amount of debate about the broader impacts on society. This is quite understandable because of the historic origins of GIS in land and property information systems. However, it is clearly important that as the technology starts to be used and more directly affect the environment and lives of people that there is a much better understanding of how to use it in an intelligent, sensible, and sensitive way. Currently, in common with the rest of IT, GIS is uncontrolled and unregulated other than indirectly by the access of spatial information and by the inherent

limitations of the current versions of the technology. GIS is not going to go away so the only real option is to develop a means of using it that retains a sense of balance and is fair to those who may be affected by it. It is not helpful to merely argue against GIS or any form of geography that uses it. The real concerns for the future are much more important than parochial debate about this or that species of human geography or social anthropology. There is not much time left and it is very important to consider ways of defining ground rules, good practice, and protocols that will provide at least a degree of regulation to a GIS industry that is currently largely out of control. Of course it may not matter, but if it does not matter at one level of IT then who is to know what the follow-on implications may be at another level?

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My overarching research interests address geographical dimensions of systems of environmental ethics, including their spatial and scalar attributes, relationships to local and larger senses of place, and expression in representations of nature. I examine these areas in the context of anthropogenic environmental change, in particular human impacts on biological diversity, both "negative" (biodiversity loss) and "positive" (biodiversity conservation).

I am finalizing a research plan to study the ethics of biodiversity loss and conservation over the next four years. It squarely addresses the political ecology research theme of the I-19 Initiative, and ties in with the Initiative's conceptual issues in many respects, including issues 1 (by studying the incorporation of particular values in GIS-based representations of nature), 3 (by finding ways to "map place onto space" in GIS), and 4 (by identifying means for stakeholder groups to interact over ethical issues associated with biodiversity loss/conservation). I am thus quite intent on developing connections with similar research projects over the span of the Initiative.

One major focus of my future work concerns how values are embedded in representations of natural habitat as affected by humans. Geographic information systems have played a central role in analysis of habitat transformation responsible for biodiversity loss; GIS technology is also central to biodiversity conservation planning efforts. Many of these applications of GIS are built on an empiricist model of knowledge, in which representations are assumed to mirror nature. Any fuzziness in the mirror is understood to be a function of biophysical complexity, which optimally will be reduced as more data become available and the predictive power of models is increased. Another major assumption involves objectivism: that values and other "subjective" elements should not intrude into representations of nature, as good policy comes from good (i.e., objective) science.

What becomes of this scenario when the social construction of nature argument is taken seriously? Two points are important for my work. First, one must effectively level the playing field by admitting that prevailing scientific constructions of biodiversity loss and biodiversity conservation priorities cannot automatically be construed as representative of "the truth," nor certainly of any majority opinion among the diverse stakeholders participating in, and affected by, biodiversity conservation efforts. This point raises some thorny epistemological problems, however, if we wish not to collapse truth into power. My own position on this matter is that of an interpretive critical realism, which holds to the possibility that we can

speak of better and worse constructions of nature, though we must seek to understand what dominant and alternative constructions exist and why.

Second, one must admit that biodiversity loss and conservation is far more than a matter of getting the facts straight. The very term biodiversity is an expression of value as well as a description of nonhuman life; any attempt to assess the significance of biodiversity loss and balance biodiversity conservation priorities against other pressing social and economic needs is irretrievably normative. This point suggests that social constructions of nature are irretrievably value-ridden; culturally-informed ethical analysis can thus play a fundamental role in understanding the ways differently-situated people make sense of anthropogenic environmental change and corrective measures designed to prevent adverse environmental impacts in the future.

My interests are both critical and constructive. At the critical level, I will be studying biodiversity conservation efforts at several scalar levels (international initiatives, national policies, and regional and local planning efforts) to determine the value assumptions in dominant representations of "positive" and "negative" environmental change. My own empirical research will focus on biodiversity conservation planning in Pacific Northwest coniferous forests; specifically, I will be working in conjunction with several Adaptive Management Areas (AMAs) that have been selected to foster active community involvement in local biodiversity planning. This work will have a constructive intent as well: to find ways to facilitate discussions of issues of ethics surrounding biodiversity loss and conservation, in particular as revealed in diverse representations of nature.

My research proposes to investigate these various representations as graphical narratives of environmental change. Biodiversity loss and conservation can be construed as a story line, with the former providing historical context, and the latter providing a future path. Most sites involved in biodiversity conservation have what could be called a "default narrative" of environmental change, usually describing major proximate causes of habitat loss, extent and significance of impacts, priority species/habitats for conservation, major land use changes necessary to protect these priority species/habitats, etc. Many of these elements are either represented in, or derive from analysis of, GIS. I am interested not only in these default narratives but the alternative narratives of other stakeholders. I intend to assemble these graphical narratives on one GIS both as a means of obtaining and re-representing stakeholder perspectives, and of providing a basis for stakeholder interaction with each other on their divergent moral understandings.

Often, people who live in sites prioritized for biodiversity conservation are differentially affected; many suffer adverse consequences. Yet their participation is crucial. The challenge in this regard as I see it is not only political; it is also a question of finding ways to "map place onto space," to provide a means to represent their local descriptive and moral understandings on a medium that is far more suited for quantifiable, georeferenced empirical data than cultural meanings. My hope is that the graphical narrative approach provides a way to make matters of value concrete.

My research objectives are explicitly collaborative; in fact, I will be seeking modest funding to partially support similar efforts in other sites targeted for biodiversity conservation. I anticipate developing a WWW-based collaborative research and educational network out of the project, to serve as a resource for academic institutions and study site communities involved in the project.

The I-19 Initiative has the potential to do fundamental work, both critical and constructive, in the realm of GIS. GIS is central in environmental planning; for better or worse, GIS-based analysis will play a major role in how people understand and shape nature in the future. It is highly important for us now to analyze how GIS-based representations constrain evaluations of nature, and to find ways to overcome its empiricist and objectivist legacy if GIS is to serve as the integrative tool it purports to be.

From GIS for Control to GIS for Creative Exploration

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Abstract

Traditional GIS base on the assumption of an objectivable reality where geographical processes can be fully modelled by observable and/or measurable quantities or nominal values (locations, attributes, relations). Such systems may be strong and efficient tools for the analysis and control of relations between objects and facts predefined within the system, but it is impossible to answer questions which go beyond the contents and structures of the system. This paper suggests the development of open systems which provide opportunities for new types of questions and responses and facilitate creativity. This move in philosophy from 'systems for control' to 'systems for prospective exploration' may also contribute to a more democrtatic use of GIS.

Reality and the notion of objective GIS

Looking at the relation between 'reality' and its 'representation' in a GIS, there is usually agreement that representation can merely be a model of reality. Nevertheless, by modeling reality in computer compatible form we assume reality to be objective, which in fact is not fully correct. In GIS reality is represented by stated quantities or nominal values (locations, attributes, relations) which are observable and/or more or less accurately measurable. This objective view of reality is also expressed by the 'transmitter-channel-receiver' information paradigm. Of course, this concept is not entirely without difficulties there is noise in the channel: The measures are not perfect, the nature of objects is 'fuzzy' but, nevertheless, statements in terms of probability are possible. This perspective represents a reality of given facts and allows its perfection through more accurate data and a higher resolution. 'Reality' in this view is represented by objects, and GIS in this sense are deterministic and predictable systems which facilitate control of facts and processes defined within the system. If the objects are well defined, then it is possible to derive the missing pieces in a linear-causal manner and in terms of a two-valued logic. This way of viewing the world amounts to the thinking of it as a 'trivial machine', to use the terminology by Heinz von Foerster (1994, 206-207). A trivial machine is characterized through an unequivocal relation between input (cause) and output (effect), results of analyses are predictable and the determination of any relations is merely a question of effort.

Classical Logic, Closed Systems and Quantification

Unequivocalness, to be without contradiction, is a quality that has its roots in classical logic with its three main propositions: self-identity, forbidden contradiction and exclusion of a third possibility. It is a thinking wherein all is clearly divided into objective being (facts, matter) and subjective thinking (reflection). Gotthard Guenther (1963, 1975, 1976, 1979, 1980) has very insistently outlined the restrictions of this two-valued Aristotelean logic: It is impossible to think the process (life, subjectivity) other than in terms of being (matter), i.e. in terms of death (i.e. dead matter). He thererfore postulates the need for logical systems which transcend the two-valued logic. The power of two-valued thinking, however, is its ability to build strong closed systems. The 'closing' of a system is achieved by establishing a finite 'vanishing point', the subordination under a common frame of quality. Quantification and this is a very aim in GIS requires previous qualification, the setting of a common quality. If it is intended to calculate in quantitative terms, then it is necessary to abstract first from qualitative differences: In order to add two apples and three pears, you have to first convert into pieces of fruit! The benefit of commonalities is accompanied by a loss of peculiarity. The establishment of a priori qualities allows to define concepts such as progress and efficiency, but also error-propagation is only understandable if it is clear what the 'true value' is. Standardization and automation again are meaningful only inside such a choosen frame. The establishment of closed systems requires predefinitions in the form of reference qualities. Unfortunately, they are easily taken for granted, the consciousness of their arbitrayness tends to vanish and give way to the notion as being just 'naturally' defined they become 'blind spots'. If the embodiment is forgotten, so-called natural qualities are often overrated, they are claimed to be true outside their restricted range of definition, their settings are used in an inappropriate context. This is definitely the case if process (life, formation, ...) is described by trivial machines, in a logic of being or dead matter. In times of normalty where a tacit consensus about the arbitrary settings exists, that may not create greater problems. In times of crisis (i.e. when the predefinitions are questioned) it becomes obvious that closed systems are insufficient.

GIS for decision support

GIS in a broader sense may be considered as instruments for decision support. If the support is in a context of control, the instruments have to give answers to specific questions. The problem under these circumstances is, that the decisions are already made and so the produced answers are rather used to delegate responsibility. As Heinz von Foerster (1994, 351-352) has pointed out, the only decidable questions are those which are in principle undecidable, because all decidable questions are already decided: a) by the manner that a theoretical framework is defined, inside which the questions are asked, and b) since the rules are determined by which statements (question answer) are connected.

To take a decision means to take responsibility. Hence decision support should not delegate responsibility by limiting the scope of inquiry and reducing the range of questions. Decision support

should enable to take (real) decisions, i.e. to take responsibility. In the context of control decisions are made at the beginning, in (and before) the design and implementation phase, they are already made hence there is no support for real decisions. But the nature of geographical inquiry relates to living processes and cannot be conducted by closed systems; these rather require the use of 'non-trivial' systems, which in principle are not restricted to predictable mechanisms. To nevertheless explain or predict geographical processes by closed systems accounts to trivializing them. In such circumstances a change from 'answering to known types of questions' to 'providing opportunities for new questions and responses' would be a more adequate approach to handle geographical inquiry. This represents themove from 'reaction within closed systems' to the 'facilitation of creativity and responsibility' or else a move from backward-looking complexity-reducing action to forward-looking creation. And future GIS should facilitate this endeavour.

Within this new approach the real potential of GIS does not ly in their capabilities for quantification, in the reflection about reality but rather in the reflection on reflection, i.e. by making transparent where decisions have been and where decisions could be made. They should help to facilitate humans to "act in the manner that the possibilities of choice are increasing" (Heinz von Foerster's ethical imperative, 1994, 234). This promotes self-organizing forces rather than restricting obedience. The aim of future GIS design is thus to replace closed systems by open tools which allow the expansion of the user's view. This shift in perspective can best be symbolized by the metaphors of 'systems for control' vs. 'open systems', 'systems for decision support' or 'systems for planning'.

Information as process rather than facts

In a open context it is no longer possible to stand outside the inquiry (to remove oneself) as is the case with systems of control. The user is not merely judging reality but is involved in a process of formation in-formation. Explanations tend to fix, to objectivate reality, they stress static aspects.   A language of 'substance' hinders the understanding of processes. This problematic can be illustrated by the use of the term 'information'. The normal use of this notion is to perceive it as a commodity: Access to information, information processing, transmission of information. According to von Foerster (1994, 196-197), this view of information represents merely potential information because information relates to process and not substance (information in the sense of in-formation). Information as facts of knowledge are not really in formation, because they lack the experience of processing. We may be overhelmed by facts and counter-facts and still be helpless if we lack experience of creative processing. Information is a process based on experience and is thus dependent on the possibilities of experience.

Conclusions

We have outlined the dominant use of present GIS as closed systems and suggested a move to open systems for creative exploration, where more emphasis is put on the learning process (in-formation) and less on rigid administration of facts. Our aim is not just the development of new methods or techniques but a shift in focus from control to creativity. Whereas our focus has been on background thoughts, the real test of these ideas will be their implementation in actual systems. At this time in this respect we can only offer questions: How should such systems look like? In which sense arethey really different from what we have now? What data models and data bases would be needed? Or else, is merely a change in perception needed, can we answer new types of questions with existing systems? Do we need computers to implement these concepts or are we better off to just use good old brain power? Phrased differently: In which ways can computers (i.e. GIS) be best used to support unrestricted imagination and inquiry of (spatial) structures and (spatial) processes?

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Providing information resources equitably to all citizens is an ongoing challenge to public sector institutions. This challenge is now taking new form with the widespread creation and maintenance of information resources in electronic form. Issues which may formerly have been framed in terms of fundamental literacy must now be reframed in terms of competencies within a digital data network environment. Questions which in the past may have focused on the costs of distributing printed texts now must include the costs of equipment, access lines and user fees which have become standard in the distribution of information resources.

As a librarian I am professionally committed to preserving the general public's effective access to a broad range of information resources. The uncertainties which face libraries in the form of scare financial support and rapidly changing technical demands have made coherent planning for systemwide sharing and services difficult. Current statewide network and service planning in Maine, described below, has pointed out many gaps in service, access, and in coherent collection of data about information resources. GIS is a tool which can be put to work on the state information policy and resource planning level.

Librarians have traditionally served as a primary interface between the general public and providers of information resources in both the public and private sectors. Librarians in public library and school settings have also had primary responsibility for helping younger users in acquiring appropriate information skills, including skill in critical evaluation of information resources.

Changes in the nature of information resources, particularly with respect to economic constraints and technological demands, have created a crisis as well as an outstanding opportunity for public libraries and the communities they serve. Geographic information systems are an outstanding example of the data resources which challenge the capacity of today's public libraries. At the same time, the tools of GIS might be put to work directly in planning the development of services which will most appropriately meet public needs.

The convergence of several factors has led to initiatives in Maine which have the potential for addressing both the crisis and the opportunities in library services. Maine is characterized by a geographically dispersed population of low density and per- capita incomes below the national norm. Maine's predominantly rural population has traditionally paid the high intrastate rates for telephone service. Maine's libraries receive only minimal state funding. Nearly one-fourth of public libraries in this state are

without telephone service. The "information superhighway" is a myth in the many Maine communities which lack local dialup access to an Internet provider.

The distribution of these services may be most vivid when mapped and visually displayed, immediately highlighting communities where services are absent. Concern that the public libraries of Maine, and many Maine communities, would be permanently left behind in an increasingly competitive and privatized information marketplace led to library intervention in telephone utility rate and regulation cases over the past two years. Grassroots advocacy from across the state has resulted in the imminent deployment of a ubiquitous school and library data network to be funded over the next seven years through reallocation of a portion of utility overearnings to school and library services.

A proposal to map Maine's information infrastructure using the tools of GIS is a counterpart to this network deployment. This information resource would focus on monitoring the development of community wide area networks, data network connections, and changes in the availability of Internet access to Maine's communities. The need for such a resource was noted in "Maine Logs On," the final report of the Maine Telecommunications and Information Technologies Planning Project. Its implementation would involve coordination of data-gathering based on GIS already underway in the state's Department of Education, Office of Geographic Information Services, and Public Utilities Commission, and Office of the Public Advocate.

Within the state's library community, the project would be closely related to a cooperative resource development project. This initiative would explore most appropriate development of interlibrary loan and document delivery, reference services and inservice training for librarians within the networked environment. Charting services and community uses through GIS will aid this effort.

Parallel with the use of GIS for monitoring and planning services is an effort to bring Maine state GIS data into wider public accessibility. The Maine Office of Geographic Information Services and the Department of Spatial Information Science and Engineering at the University of Maine have initiated BASIN (browsable hyper-archive of spatial information on the net). In its initial phase, state geographic data will be provided to the University for research purposes. After the school and library data network is in place, the resources of BASIN are intended to be made available for public library and school use statewide.

All of the developments outlined above are in the earliest stages of development. Because their potential could be realized through coordination of resources already being developed by separate agencies, there is the possibility of creating a unique public resource without allocation of significant special funding.

My presentation would describe these initiatives, their background and their implications for public access and public information policy in this state. Comments on the suitability of this approach in other settings would be invited and welcome from conference participants. In terms of the conceptual issues outlined in the call for papers, this presentation would be tied most closely to issues 2-4, relation of these resources to marginalized social groups, GIS-based decision-making process, and participatory tool.

GIS and Environmental Equity: An Analysis of the Assumptions

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Introduction

In the past, GIS research fell into the general categories of how to build the tools, how to use the tools, and how to install the tools in an organization. Recently, however, a new prong of GIS discourse has emerged - the social implications of GIS (Pickles 1995). The idea of a critique of GIS technologies and their associated prescriptions for solving problems is one that is important and long overdue. The critical analysis of GIS stems from two interrelated ideas. First, most build upon the idea that GIS is a social technology, developed and operating in a culture that adds certain biases. Second, GIS have social consequences, not only for the people on the receiving end of decisions made with such systems, but in terms of causing fundamental shifts in how we think about knowledge (Sheppard 1995).

Equity is an emerging consideration in the environmental policy arena. The principle of environmental equity is one where no subpopulations are bearing a disproportionate risk from environmental hazards (Scott 1995). The recent literature distinguishes two types of equity (process and outcome) (Cutter 1995). Process equity examines the causal mechanisms for inequities, while outcome equity measures the distribution of hazards compared to the distribution of marginalized populations. Environmental equity was given legal and political legitimacy when the US Environmental Protection Agency established its Workgroup on Environmental Equity in 1990, and President Bill Clinton signed Executive Order 12898, which ordered federal government agencies to examine policies and procedures for possibilities of environmental inequities, into law on February 11, 1994 (Cutter 1995).

This paper explores the inherent biases in environmental equity analyses techniques and GIS technologies. It is suggested that because of the inherent biases in technique and technology, a true picture about the state of environmental equity in a given study area may be skewed and incorrect. These biases are not only methodological and procedural but can also be attributed to the societal practices operating behind the scenes.

Inherent Biases in Environmental Equity Analyses

The first, most obvious area of potential bias in an environmental equity analysis is in the stage of data collection (or non-collection). Most environmental equity studies rely on secondary data sources, either collected by the US Census Bureau, the US Environmental Protection Agency, or some other federal or

state government agency. Obviously when one relies on data collected by someone else, that data is already "laden with theories, purposes, and social norms of the agencies who collect them (Sheppard 1995)." It also severely limits the questions that are asked, much less those questions that can be answered. In addition to the possibility of having an environmental equity analysis being data-led and not theory-driven, there are some general questions about the quality of those widely-used secondary data sources. The Census Bureau was quite sure it undercounted minorities and homeless during the 1990 census. Most of the environmental hazards databases are self- reported, leaving many questions about both attribute accuracies (chemicals, amounts released) and positional accuracies (Cutter et al 1995). Data definitions are a possible bias which most researchers are constantly aware. That does not, however, alleviate the fact that definitions can not only change results but they also change the social implications of those results. The poverty line' definition is one well-known example of this phenomenon (Miller 1995). Finally, many of the national hazards databases provided by EPA, such as the Toxic Release Inventory (TRI), contain facilities that are positionally incorrect (Wagner et al 1995).

Another possibility for the introduction of bias into an environmental equity study is the scale of the analysis. In geography, this is usually referred to as the Modifiable Areal Unit Problem. The perfect scale for an environmental equity study would be at the individual level, measuring each person's equity and correlating that with some social characteristic. This, of course, is not possible in most cases. Thus, researchers must use population data aggregated to some areal unit such as census block groups, census tracts, zip codes, etc. Problems arise because with each level of aggregation and between two regions of the same study area with different-sized aggregation units, the results are usually different (Cutter et al 1996). This results in a social bias as well since downtown areas, where large numbers of minorities reside, generally have many small areal aggregation units while suburban areas have fewer, larger units, skewing results within study areas.

Inherent Biases in Geographic Information Systems

Many authors have begun to lay out their specific reservations about GIS, both as a technology and as an area of study in geography. Some point out the fact that the very use of GIS to solve a problem constitutes a bias, in that using a GIS prescribes certain ranges of action, use, or purpose. Often this prescription of action manifests itself in the transformation of existing goalsto accommodate a new technical means or reverse adaptation (Veregin 1995). Another general theme pervasive throughout the social theory/GIS literature is the inappropriateness (for some problems) of the logical structures which make up the GIS. Sheppard (1995) states that "our knowledge cannot be reduced to a deductive logic because human intelligence incorporates more than deductive reasoning in how we make sense of out surroundings (p. 9)." Many of the other critiques of the technology can be broken down into major GIS subsystems, representation, collection, and analysis, and access issues.

The first subsystem of GIS that has the potential for bias and error is the way in which we digitally represent the world. First, generalization is not only a function of technological feasibility and necessity, but also includes cultural contexts and scientific paradigms (Veregin 1995). Second, one of the most basic rules in GIS data representation is that space is mutually exclusive and collectively exhaustive, a property that is not necessarily so. Ethnic neighborhoods are another phenomena that rarely stop at a given boundary but generally blend near border areas. Third, GIS have limited capacity to examine attributes between locations (situational characteristics) as opposed to attributes at locations (site characteristics). Data representing flows and interactions are expensive to store and maintain and are difficult to represent. They are therefore marginalized in any GIS analysis (Sheppard 1995).

Every GIS analyst has dealt with problems with data collection, the next subsystem of examination. Most dangerous, perhaps, is the GIS data that are not collected. Any data not collected will obviously not be used in any analysis. Since most GIS rely heavily on secondary data sources, social theorists also put forth the idea that because the state is the collector of most GIS socioeconomic data, the state is determining what questions can be asked and in what form. Generally, the variety of knowledge and wisdom possessed by diverse individuals and social groups and gathered in course of their experiences is not considered worth collecting by large state agencies.

Three main ideas emerge with regards to the problems in the data analysis subsystem of GIS. In addition to the fact that GIS is almost completely based on logical, deductive positivist empiricism, simple concepts such as near', far', round', or long' are very difficult or nearly impossible for the GIS to handle as well (Frank et al 1992). This, of course, keeps them from being used and perhaps causes some questions not to be answered, a true concern when one studies population proximity to hazards, for example. Finally, GIS analysis is often simply an analysis of spatial patterns looking for repetition, clustering, or some other sort of non-randomness. Unfortunately, different processes may produce the same patterns and the different patterns may be the result of the same process (Taylor and Johnson 1995).

The final characteristic of GIS or any technology is access to that technology. Are certain groups systematically favored or disfavored in relation to access to geographic information and geographic information technologies. While powerful hardware is relatively cheap, the datasets that need to be analyzed are getting larger and more complex, reducing the hardware effectiveness. Those intuitive GIS user interfaces are hardly intuitive to non-experts and are generally tailored to certain types of industry-specific tasks. Unfortunately, this controversy matters immensely. Harris et al (1995) states: "in the mode of top-down data creation, GIS empowers the powerful and disenfranchises the weak and not-so-powerful via the selective participation of groups and individuals (p. 202)." In fact, Harris et al (1995) say it best as: "Without equitable access to GIS data and the technology, small users, local governments, nonprofit community agencies, and nonmainstream groups are significantly disadvantaged in their capacity to engage in the decision-making process (p. 203 after Edney 1991)."

Questions to Ponder

Given that we have identified some of the inherent biases in environmental equity analysis and geographic information systems, what can be done to alleviate them? While we do not claim to know the answer to that question, there are some fairly clear areas where research can be done to improve the social implications of GIS/environmental equity studies, especially from a policy perspective.

First, what is the ideal unit of measurement of environmental equity? Can the imposition of raster areal units as aggregates of block level census data remove part of the modifiable areal unit problem? Second, how important is local knowledge in finding environmental equity problems and their solutions? How can policy makers operationalize the concept of incorporating local knowledge? Can that local knowledge be represented spatially? Third, how might local governments improve citizen access to geographic information and technologies, taking into account the general lack of geographic concept in the general population? Four, what is the accuracy of federal and state hazards and socioeconomic databases, especially in the positional information? Can this accuracy be systematically improved with regulation changes, fieldwork, or other methods? How should a lack of confidence in the data be expressed in any proposed solutions? Are primary data collection methods warranted in certain situations? And finally, are the correct equity questions being asked due to data-driven research? Instead of proximity to hazards, perhaps we should be examining actual levels of exposure per household or probability estimates of exposure?

Conclusion

Rarely has GIS been used to analyze the social context of communities and how environmental hazards are embedded within these social contexts. One mechanism for examining the social context of communities is through the incorporation of local and historical knowledge into GIS analyses. There are a number of other areas where further research is required to enable us to address some of the issues in environmental equity research. The first is the need to resolve the scale question--what is the most appropriate spatial scale for understanding both the process and outcomes of inequities? The second research area is to move beyond the single parameter type studies, to more complex interactions between multiple sources of potential risks. Lastly, we need a better understanding of environmental threats, locational patterns, spatial scale, the social geography of places, and how GIS can aid in our understanding of these complicated interactions. Once accomplished, this should provide a strong social scientific basis for environmental policy decisions.

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As for any social technology, use of GIS necessarily entails taken-for-granted assumptions about the world, which are taken for granted simply because they are hidden within what is assumed to be conventional or normal analysis. The resulting appearance of objectivity stems from unacknowledged but implicitly accepted presuppositions about what GIS is, what geographical analysis entails, and what the social problems are that GIS- based analysis is being employed to solve. The GIS & Society research agenda takes as its starting point the necessity to unpack these unacknowledged presuppositions, in order to provide a more global (if never objective) assessment of the societal implications that they carry with them. In this position paper we attempt to indicate how this may be done through a thought experiment. We consider current ways of using GIS to analyze toxic risk, and progressively peel back layers of assumptions and presumptions to show the ways in which these limit the types of questions asked and thereby the social problems that can be addressed. We hope that these insights also may be useful for constructing alternative analyses which are capable of addressing a wider range, and perhaps a more fundamental set, of problems.

Consider the following state-of-the-art GIS analysis of toxic waste (our thought experiment). GIS analysis begins by locating TRI (toxic resource inventory) sites and toxic waste dumps, and inventorying the chemicals to be found at these sites and probabilities of unwanted airborne emissions. Through use of plume models, the likely geographical distributions of these emissions are then portrayed with GIS, and converted into a comparative risk analysis of the expected number of deaths by location over (say) a ten year period by cross matching risk estimates with demographic data. Employing census information on the ethnicity, age and gender of the population, available at the block level (?), GIS is used to calculate the inequity of risk by demographic category, providing statistics of environmental racism, sexism or ageism, also broken down by location. Finally, these results are put into a spatial optimization procedure to prescribe the location of new sources of environmental toxins with the goal of redressing current inequities as efficiently as possible, as well as developing such emergency procedures as evacuation plans.

We emphasize immediately that this kind of analysis is an important first step in employing GIS to the problem of environmental toxins, and one capable of bringing more sophistication to debates about environmental racism that is to be found in much of the current literature. Indeed it is an analysis we intend to begin with in our own research. At the same time, however, it forms a useful case study for

unpacking taken-for-granted presuppositions which bracket the type of analysis possible with this research design, with an eye to how one might transcend this bracketing.

Consider, first, a relatively trivial issue: the definition of toxic waste underlying the data provided. Excluded from this official information is any evidence of illegal or officially unacknowledged point sources of waste, which are not officially reported because either they are illegal, or are claimed to be of such low risk that they are not worth reporting (E.G. incinerators), or are state secrets (DOD dumps). A second unreported source of toxicity is ambient: not only trucks carrying hazardous waste, but all vehicles (creating lead pollution in soils adjacent to roadways), and power lines (claimed also to be a source of environmental toxicity). Information on additional sources of these types may well be available, from community residents or activist organizations, but are left out of the analysis from the beginning. In this sense, the analysis presupposes official definitions of environmental toxics and, like any analysis based on secondary data, is constrained by the explicit and implicit agendas of those charged with data collection. The remedy: re-examination of official definitions, and searching for alternative information reflecting other views of toxicity.

A similar problem, of course, plagues use of tables converting densities of pollution into health risks, estimates of which are notoriously plagued by uncertainty, lack of information about low level risks, and conflicting studies funded by conflicting groups (E.G. radiation risk, second hand smoke). Similar problems may plague plume models. Restriction to such models certainly presumes that air transportation is the only source of risk (as opposed to, say, groundwater), and debates about dispersion parameters may be as contentious as those about health risks at various toxic concentrations. Consider next the estimation of environmental risk. Given the manifold variety of toxins, and the multiple health risks associated with them a full analysis of the multi- dimensional risk picture, categorized by location, promises to be bewildering in its complexity. Furthermore, the challenges of cartographically representing even two variables covarying on a map are such as to discourage attempts to geographically depict multi-dimensional risk. There is thus an enormous temptation to reduce this to a uni-dimensional measure. Such a reduction would be consistent with current Federal practice of employing comparative risk analysis to set agency priorities, because it is claimed to provide an objective measure for planning purposes. It is highly likely, therefore, that comparative risk analysis, an estimate of the total deaths expected from toxic emissions of all kinds, categorized by location, will be employed in GIS analysis. This measure is, however, highly problematic. In a survey of comparative risk analysis, Donald Hornstein (1992) has revealed a number of its unacknowledged presuppositions, including: the substantial departure of such estimates from human assessments of reasonable risk since they fail to take into account subjective assessments of utility; inattention to the fact that scenarios minimizing total risk may be highly inequitable and thus undesirable for other reasons; invalid assumptions that risk assessments, by experts as well as the public, are entirely based on rational decision- making; and the status quo bias associated with comparing any environmental risk only against known and well established alternatives (as opposed to more fundamentally different alternatives; a theme to which we return). To his list we would certainly add

the androcentric idea that only human death is relevant; a view which restricts the moral community of this kind of analysis to other humans.

When GIS analysis turns to assessing who is at risk, an analysis broken down by race, gender and age, with its implications of discrimination, is easily carried out but again presumes certain social principles which are highly problematic. Missing, for example, is the question of class. The US Census publishes no data on economic class, and even information on Weberian (wealth-based) class categories is only available at higher levels of aggregation than race. To attribute inequitable distributions of risk by race to environmental racism presupposes that no other social categories are causally relevant. Social theory suggests, however, that unequal treatment by class is at least as fundamental to a capitalist society as race-based inequities. Race and class certainly are closely correlated, raising the question (which writers on environmental racism only recently have started to acknowledge) of whether observed inequities are race based, class based, or both. This is compounded by the fact that classism is not illegal in the US whereas racism is (as is sexism and ageism -- even though the chances of changing your social class are much lower than the chances of aging). Thus geo-demographic analysis, combined with the norms of US jurisprudence, may plausibly focus attention on the wrong cause of environmental injustice. As long as people of color disproportionately occupy lower social classes than whites then treating the inequity to be addressed as racial will have little impact if the real cause of inequity is class based. Multivariate analysis may be capable of sorting out the relative causal efficacy of race and class, at certain levels of aggregation (although such results are always plagued by problems of geographic scale and the potential for ecologically fallacious reasoning). This certainly would require, however, a different kind of analysis, and a broader spectrum of data, than is suggested by our thought experiment.

There is a closely related problem of identifying the source of discrimination, and thus mis-specifying the causal chain of analysis that has been raised by Vicki Been (1994). A static spatial analysis of the distribution of risk around extant toxic sites begs the question of whether the sites were located in minority neighborhoods (and if so, whether this racially or economically motivated), or whether depressed housing values around toxic sources, reducing the desirability of these neighborhoods, have turned these into minority neighborhoods (again, either due to minorities low income or racially biased housing markets). Only an historical geographical analysis is capable of addressing these questions, but this is difficult with current (static) GIS technology. This raises the danger that GIS analysis will be interpreted according to the former scenario, which is currently the dominant approach. This scenario, however, implies that the solution is to change the nature of siting decisions. If this scenario is wrong, changing siting decisions only has a short run effect, as housing markets then adjust top relocate minorities into the newly undesirable locations. If the alternative scenario is correct, a completely different approach may be necessary; one aimed at both eliminating housing market discrimination and eliminating either income inequality or the unequal chances that different demographic groups have of belonging to more prosperous income groups (i.e. eliminating class or race as a socially significant category). Clearly these

latter policies challenge the social status quo far more fundamentally than the former policy; a further reason why the former is likely to be favored whether it is correct or not.

A final, and arguably the most fundamental, issue has been raised in a broader context by Robert Lake and Lisa Disch (1992) in their analysis of state regulation of toxic waste in the US. The entire way in which the empirical problem has been set up, including the what has been defined as information, the type of spatial analysis attempted, the measure of risk, and the ensuing policy prescriptions, presumes that toxic waste emission is inevitable and should be controlled by locational strategies to minimize its impact. Indeed, as Lake and Disch point out, the entire US legal and regulatory apparatus, which is taken for granted as the context of the GIS analysis, incorporates the same presumption. Notwithstanding practical reasons for dealing with existing emission problems in this way, giving a high priority to using GIS for this type of study tends to reinforce the perceived validity of such presumptions, making it difficult, or unpopular, to ask about such more radically different scenarios as the cost effectiveness of green production methods that do not rely on toxins and/or minimize emissions. How could GIS be used to address such issues? Clearly very different kinds of data would be needed (E.G. on production methods, their costs and environmental impacts, on technical change, on the capacity of the earth to absorb toxins); a different kind of geographical analysis would be required (E.G. a long term analysis of human-environment trade-offs rather than examination of spatial patterns); and different goals would have to be formulated.

Even discussion of such extensions makes visible the ethical presumptions underlying any analysis of environmental justice -- presumptions not about procedural ethics (the care and honesty of research practices) but about ethical communities (Lynn 1995). If goals shift from allocating the current environmental burden of human activity on humans, to one of minimizing any environmental consequences for humans and non-humans, clearly this constitutes a different ethical position and one which requires an even more fundamental rethinking of the role of GIS.

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The primary objective of this paper is to contextualize GIS technology onto five broad intellectual/social dimensions in an attempt to develop a critical theory of geographic information science. This position paper contains three sections. The first section outlines major elements of a critical theory of geographic information science. This section also serves as a summary of my research interests regarding the topic of GIS and society. The second section of this paper presents a case study on GIS-based environmental equity analysis using the critical framework presented in section one. The third section summarizes my future research plan on the topic of GIS and society.

1. Contextualizing GIS Technology: Toward a critical theory of geographic information science

Current conceptualization of GIS technology is instrumental in nature without closely scrutinizing the social constitutedness of this electronic tool. By synthesizing recent literature on GIS and society, this paper aims to develop a critical theory of GIS technology that contextualizes GIS at the following five different, but interrelated, dimensions: ontology, epistemology, methodology, ethics, and politics.

a. GIS Ontology

Ontology refers to the theory of existence, which asks the fundamental question what exists. The answer to this question will determine what are accepted as "facts" and what can be known. In the context of GIS, ontological issues refer to what GIS researchers believe exist and how to represent this existence inside a digital computer. In technical terms, the ontology of GIS lies in the domain of data modeling. According to Goodchild (1991), the data modeling process is to study "how the infinite complexity of the geographical world can be represented within a discrete finite machine." From an ontological point of view, the current generation of GISers believes that reality can be represented in terms of location (where), attribute (what), spatial relationship (how), and time (when). Everything has been discretized. In terms of space and spatial relationships, GIS is deeply embedded in Euclidean geometry, in which the real world has been abstracted into points (0-dimension), lines (1-dimension), polygons (2-dimension), and volumes(3-dimension). Attributes are grouped and labeled according to different classifications and categorizations. Spatial relationships are represented using rigid physical topological relationships in terms proximity and

adjacency. Time is also treated as a one-dimensional discretized element. Overall, current GIS ontology is embedded in a Newtonian conceptualization of space and time. Social relationships are not adequately represented. Among all possible worlds, GIS ontology is only one way of representing the world. Whether it is the best way or not needs further scrutiny. From a critical theoretical point view, we need to ask, can the real world be known through the points, lines, and polygons as currently represented inside GIS? To what extent has such an ontological assumption distorted the reality and affected our way of knowing? What are the social and theoretical implications of such a GIS ontology?   Can social relations be incorporated as an integral part of GIS data structure?

b. GIS Epistemology

Epistemology refers to the theory of knowledge. It asks the fundamental question how can we know it or how do we know what we know. The answer to this question will determine what kind of logic researchers will use to derive knowledge. From an epistemological point of view, how space/place is defined inside a GIS affects not only what we can know, but how we know it. The fact that GIS is essentially a computer-based technology has implicitly determined the Boolean logical nature of GIS applications. Two main epistemological positions dominate the current GIS reasoning process: visualization-based empiricism (VBE) and analysis-based rationalism (ABR). The first position sees knowledge as the product of sensory perception, resulting from a kind of mapping or reflection of external objects, through our sensory organs, possibly aided by different observation instruments, to our brain/mind. Knowledge has to be developed by observation.   The second position sees knowledge as the product of rational reflection through the integration of GIS with spatial analysis and modeling.   The wide proliferation and adoption of GIS techniques have restricted our pursuit of knowledge to Boolean logical reasoning according to either the visualization-based empiricism or the analysis-based rationalism.   Has GIS technology inadvertently marginalized other insightful epistemologies?

c. GIS Methodology (Praxis)

The combination of ontology and epistemology defines methodology, which refers to a set of rules and procedures regarding how information is collected and how analysis is conducted. From a methodological point of view, GIS is simply a transformation of the assumed ontology and epistemology into a set of operational rules. The ultimate frame of reference for any truly meaningful application is hidden beneath several thick layers of technical operations. With the increasing level of automation, geographic analyses are being further functionalized and rountinized into various overlay and buffer functions with fewer and fewer users caring about the ontological and epistemological assumptions behind these operations. The question of why to perform a particular operation is rarely asked. Because of the exclusive technical nature of GIS, mere technical advances in the absence of thoughtful and sound research design do not

necessarily advance our understanding of physical and social systems. Current GIS applications are hampered by the tunnel-vision of positivism. Sound methodology in GIS application does not necessarily mean how many analytical modules have been incorporated. Instead, we need systems with a greater theoretical breadth. If GIS methodologies are not contextualized to ontological and epistemological dimensions, mere technical advances primarily based upon the rehabilitation of quantitative, technologically structured tools of the past, may only postpone the real issue under investigation. In many real world GIS applications, the seemingly scientific, hi-tech-based GIS methodology is primarily ad hoc and full of subjectivities. But these subjective and problematic aspects in GIS methodology are rarely revealed to the decision makers and the general public. Only through the lens of a critical theory of GIS can we see clearly the methodological problems existing in most GIS applications.

d. GIS Ethics

Ethics refers to the theory of values that deal with human conduct or practice with respect to the rightness or wrongness of certain actions and to the goodness or badness of the motives and ends of such actions. The ethics of GIS define the rules of conduct commonly recognized and practiced in GIS applications. Scholars have increasingly recognized that the new technology's primary goal is to increase the surveillance capabilities of the academy, the state, and the capital. Does GIS technology foster democratic practice, broaden the distribution of, and access to, information, and reduce the burden of work on those who adopt its rigors and accept its benefits, as claimed by GIS enthusiasts? Or, as some critics have argued, that the ethical inconsistency is inevitable because of the utilitarian concept. I believe that the recent debate on the various ethical issues should be an integral part of the critical theory of GIS technology.

e. GIS Politics

GIS politics should explore the institutional --executive, legislative, and judicial-- infrastructure for the adoption and application of GIS technology in the new electronic democracy. In a technologically institutionalized society, it remains controversial regarding who has the political power and clout to have a final say in various decision making processes. How has the proliferation of GIS data bases and differential access to spatial data bases influenced the abilities of different social groups to utilize information for their own empowerment? GIS politics should also explore the possibilities and limitations of using GIS as a participatory conflict resolution tool. To what extent, should GIS be utilized in various executive, legislative, and judicial processes in a democratic society? The legal and regulatory frameworks in GIS research and applications remains to be determined.

2. A Case Study of GIS-Based Environmental Equity Analysis

In this section, I want to use the critical theory outlined above to contextualize the application of GIS technology in environmental equity analysis. In doing so, I want to illustrate the profound ramifications of GIS technology on the social problems. The issue of environmental equity -- whether minorities and low income communities across the United States share a disproportionate burden of environmental hazards -- has attracted intensive interdisciplinary research efforts in recent years. Because of the increasing availability and easy access to several national spatial databases, such as U.S. EPA's toxic release inventory (TRI) and Census Bureau's TIGER files, GIS technology has been widely used in environmental equity analysis during the past five years. However, numerous critically important issues with profound social and legal implications have not been examined in GIS-based environmental equity analysis. The purpose of this empirical study is to contextualize these issues using the critical theory of GIS.

The following preliminary conclusions have been reached:

a). At the ontological level: what is being represented in a GIS, including both geographical boundaries (census block, census tract, zip code area, county boundaries) and attribute data (such as census data on race/ ethnicity and socio-economic status, EPA's TRI data), may not be appropriate to conduct environmental equity analysis. The results of environmental equity analysis are biased toward how the data were collected.

b). At the epistemological level: Risks are socially amplified by various social and ethnic groups. The perception of risk cannot be unproblematically modeled. Also, certain aspects of risk assessment and evaluation cannot be reduced to computational details. In order to use GIS, everything must be converted into numbers, which may mislead rather than reveal what is really going on.

c). At the methodological level: GIS-based environmental equity analysis heavily relies on mapping and statistical techniques. Depending on how the maps are designed, GIS can be used more easily to lie with maps. As for the statistical techniques, depending on the geographical scale and the aggregation method used, we can basically come up with whatever desired results we want. Or in other words, the stubborn modifiable areal unit (MAUP) problem still persists, and because of ignorance of this problem, many authors have committed a cardinal sin in statistical analysis -- ecological fallacy.

d). At the ethical level: Uncertainties in GIS-based environmental equity analysis have posed many ethical issues in scientific and policy-oriented research. It has become more and more difficult to profess to be impartial scientists. Instead, many researchers have become hired guns, producing research results that are dictated more by the funding agencies than by what

is really going on in the real world. GIS and other technologies have contributed to, if not caused, this ethical dilemma.

e). At the political level: Environmental equity analysis is actually a struggle among grass-roots community organizations, corporate America, and various state apparatus in executive, legislative, and judicial branches. The controversies are a reflection of far more broader issues related to contemporary politics. One very important issue is whether GIS can be used for the empowerment of disadvantaged groups to ensure an equitable distribution of environmental hazards across class and race lines. Has GIS promoted a technocratic geography serving the interests of existing power structures? Right now, as GIS technology currently stands, who can access this technology and enjoy the benefits of it will depend on who is willing to pay, not necessarily on who really needs it.

3. Future research agenda

My long term goal is to establish a comprehensive theory of geographical information science which addresses spatial data handling issues at the ontological, epistemological, methodological, ethical, and political levels. My short term goal is three-fold. First, I want to explore the alternative ways of representing and knowing reality in a GIS, especially how to incorporate the non-computable aspect of people, space, and environment into the GIS modeling and reasoning processes. This belongs to the ontological and epistemological levels of the critical GIS theory presented in section one. Second, I will continue to explore the perplexing modifiable areal unit problem (MAUP) and ecological fallacy issue in GIS-related analysis and modeling process. In this regard, I am interested in implementing Tobler's scale-independent or frame-independent analysis and modeling procedures in a GIS. I also want to explore here the hierarchical theory of GIS applications using multiple-scale and multiple-zoning schemes. Third, I believe that the best way to publicize research results regarding the topic of GIS and society is to develop a new curriculum on the social implications of GIS technology in order to bring these critical perspectives into the classroom to educate our students as well as the general public. Current GIS education is dictated by the twin goals of teaching ABOUT (GIS technology itself) and teaching WITH (GIS for problem solving). I suggest that a third dimension must be included as well:, that is, teaching AGAINST (a broader social/intellectual context) for which the critical theory of GIS technology will play a very important role.

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Recent years have seen an increase in the number of works in geography concerned with contextualizing and examining social issues related to information technology. Part of this ongoing research agenda has examined technologies frequently used or in some cases developed by professional geographers. The stance taken in these works is neither an unreflective enthusiasm about advances in information technology or a technophobic response. Instead, these works tend to start from the assumption that information technology is both indicative of structural changes in our society and economy as well as a producer or catalyst of these changes.

While some authors have attempted to examine GIS technologies and practices from these perspectives, remote sensing and image processing technologies have not been similarly studied. Increasingly, however, the information used in many GIS databases stems from remotely sensed images. In my research I have investigated some of the perspectives which accompany the uses of remotely sensed images and their use in GIS technology in order to point to the ways in which particular ideologies and ways of viewing the world are inherent in their use. I also explore some political and social issues related to the practices of remote sensing.

My research interests deal with the following themes:

- The logic of remote sensing and GIS. By this I mean the ontological and epistemological basis of the practices of remote sensing. Particular ideas of space, objectivity, and representation are implicit in the current practices and technologies of remote sensing and GIS. Examining these underlying assumptions helps reveal the problems and limitations inherent in using remote sensing for social research. Also, it is possible that these established notions of space and objectivity are in fact lagging behind both recent theoretical work on these topics and new innovations in information technology.

- The origins of remote sensing. Along with the underlying assumptions which guide remote sensing are particular aspects of a military ideology. In part this stems from the military origins of remote sensing and the uses for which it was initially conceived. In order to understand and identify this ideology, these origins need to be investigated.

- Remote sensing and surveillance. Remote sensing is generally defined as a set of practices and technologies used to perform surveillance upon objects, natural resources, and populations from a distance. Many aspects of the nature of this surveillance have yet to be theorized. In addition, there are serious ethical questions which need to be asked about the use of remote sensing for various surveillant purposes by researchers, commercial interests, and government agencies.

- Differential access to remotely sensed data. Data from remote sensing is unevenly distributed across international and national scales, and also between various levels of user groups such as government agencies, business, and academic researchers. This uneven distribution begs the question of whether a situation of unfair advantage exists for those who have disproportionate access to remotely sensed images, image processing technology, GIS software and hardware, and technical expertise, and what the broader effects of this inequality are.

- Population and natural resource management. Remote sensing implies the imposition of a particular type of spatial order upon areal objects. What are the effects of this ordering upon both resource areas and populations? The recent use of remotely sensed images in a GIS system enhanced through virtual reality for border definitions in the Bosnia Peace Accord demonstrates the importance of understanding the ways in which remote sensing can be used to impose a spatial order upon a region through policy-making.

Each of these themes suggest issues worthy of consideration by social scientists. Up to this point, however, there has been little in the social science literature on the social implications and uses of remote sensing. I hope to elaborate upon each of the above themes in subsequent research. Briefly, here are some of the conclusions I have reached so far.

An investigation of the ideology and way of viewing the world inherent in remote sensing must start from examining the actual origins of remote sensing technologies and practices. It is my conclusion that the roots of remote sensing lie firmly within the military sphere. This is also true of remote sensing's precursor: aerial photography. Both remote sensing technologies and aerial photography were initially developed by Western militaries for the purpose of monitoring perceived threats abroad. Thus militaristic notions of the control and administration of space are deeply embedded in remote sensing practices. Concurrent with these notions are ideas of a fixed, external, objectivity; and a view of remotely sensed images as accurate representations of an observable reality.

As remote sensing was initially conceived by the military as fulfilling a surveillant role, the nature and purposes of surveillance must be taken into account in an examination of remote sensing practices. Surveillance and its role in modern society has been highly theorized in the works of many poststructuralist scholars. The ideas of these theorists have yet to be taken up by investigators of remote

sensing, though they have by recent researchers of the social effects and implications of GIS. At the present time, questions of access to remote sensing images and technologies also take on important roles as the Federal government moves towards declassifying and disseminating remotely sensed images. Another currently relevant research question concerns the strategic uses of remote sensing by other militaries and governments. As an increasing number of nations begin to launch their own satellites, geopolitical issues become ever more important in discussions of remote sensing surveillance. To what extent will a few nations control the production and distribution of remotely sensed images and data obtained from them? What are the political ramifications of future changes in international possession of surveillance satellites and remotely sensed data?

Remote sensing has proven to be a very useful tool for those concerned with natural resource discovery and administration and with monitoring ecological characteristics of areas. Yet questions remain as to how the particular ways in which remote sensing and image processing function (especially when combined with GIS) as a tool for managers for making decisions about the definitions and best uses of areas. As remotely sensed data is often used to identify areas as particular resources, demarcate their boundaries, and then determine their optimal uses, it is important to understand how the nature and logic of this technology can lead to specific natural resource management practices.

In conclusion, I think examining these aspects of remote sensing offers exciting possibilities for future research. From a social science point of view, the non-technical aspects of remote sensing technology and practices are quite under-theorized. Given the close interdependence between remotely sensed data and GIS, an analysis of these aspects of remote sensing could play a valuable role in the NCGIA's Initiative 19 on GIS and Society.

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In its work towards the establishment of the new empirical scientific method in the late seventeenth century, the members of the Royal Society of London advocated certain principles for the interpretation and representation of the world; significant among these are the dissociation of the individual self from subject matter, simplicity of context, a heavy predominance of mathematical rationality, an atomistic view of material things, and the establishment of a knowledgeable elite. These principles were incorporated in the Royal Society's cartographic activities, of which some continued publication even into the nineteenth century. This influence is evident through out the modern period and well into the twentieth century. They appear as signatures of the modern cartographic style: plainness, or the lack of iconography as visual metaphor; simplicity of context through the elimination of competing viewpoints or connection to related things; a predominant emphasis on mathematical accuracy; utility; and communication. The purpose of 'Plain style' representation was to make information easier for general audiences to read by making it less demanding of thought on the part of the readers.

These principles are largely still advocated in our contemporary cartography textbooks.

> Simplicity is highly desirable and is a result of excellence. Because simplicity is relative in a context,it cannot be defined, but it can be recognized... A basic requirement in graphic design is a willingness to think in visual terms, uninhibited by prejudices resulting from previous experience... The controls of map design are the objective of the map, the reality of the area being mapped, the scale, the audience, and the technical limits within which the map must be prepared.

> (Robinson, Arthur, Sale, Randall, Morrison, Joel. Elements of Cartography. Madison: University of Wisconsin Press, pp. 280-2.)

The research I am particularly interested in is in the original regard of these principles as "manly", and others as "feminine and juvenile." The purpose of my research is to bring to light the historical source of these ideals, and to examine the consequences, in the context of gender studies, of modern cartographic design principles established by men in part towards an ideal of masculinity. My hypothesis is that the unacknowledged consequences of Plain style mapping are cultural and logical repression, and an attack

on emotive statements and abstractions such as worldviews and spirituality. The problem is not in the practice of cartography by either men or women, but in the power of the established cartography structure that needs examination for embedded gender bias or biases toward other perspectives. I use a semiotic approach that focuses on the use of particular representational signs, cartographic or as GIS.

This research addresses the first conceptual issue outlined in the NCGIA Specialist Meeting Call for Participation: "how particular logics and ways of understanding the world have been incorporated into GIS and how alternative forms of representation may have been neglected." An example of a contemporary epistemological problem of Plain style representation is found in the application of GIS to holistic principles of ecology. For example, U.S. Forest Service ecologists, attempting to implement ecosystem management as a result of a lawsuit by University of Wisconsin botanists, have argued that GIS fails to accommodate new taxonomies of ecological zones. Principles of ecological thought resemble the concerns of cartography before the modern age, and could potentially benefit from the research addressing the possible "masculinization of cartography and GIS.

In addition to my research on Plain style representation, another aspect of my work which falls within the initiative research agenda is the use of GIS in environmental conflicts. I have the principle responsibilities of developing GIS for the U.S. Department of the Interior, Bureau of Land Management for the 20 states of the northeastern United States. Our agency frequently experience conflicts between oil and gas development and environmental interests. These take two forms: between private industry and the Federal NEPA process, and between the Federal decision to lease for development and the opposition of environmental groups to leasing. The timeliness of the NCGIS research agenda coincides with the need for input into new national modernization platforms being developed by BLM, the Forest Service, and the U.S. Army Corp of Engineers. It will thus shed light upon the third conceptual issue, how the knowledge and needs of different social groups can be incorporated into government GIS-based decision-making.

The two issues described above both fall within the research themes established by NCGIA for the 'GIS and Society' Specialist Meeting, of the control of peoples and the political use of natural resource development.

The combination of GIS and postmodern theory creates an exciting opportunity to investigate alternative designs of geographical representation or those which were suppressed in the modern era. My future research will continue to examine the structuring of gender-assigned human qualities in cartography and GIS, and the merging of ecology and GIS for ecosystems management. It will in the future move into the exploration of alternatives which GIS can offer, and whether those alternatives are allowed institutionally by the Federal government.

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What is the essential character of a map? Is it a faithful "image of reality" or is it a "manifesto for a set of beliefs about the world"? This question is central to the effort to understand cartographic representation in the context of digital geospatial databases, which (in some venues at least) are rapidly replacing traditional manually- produced "paper" maps. While paper maps and geospatial databases are both products of human agency working through technological means, new mechanical and digital technologies have led to new modes of cartographic production and new paradigms for the representation of geographical phenomena. According to some critics, the most important change wrought by these technologies is the ascendance of a new geospatial "science" focused on the goal of producing ultimately truthful and objective representations of the external environment. This goal is seen as a byproduct of the new technological means, with its appeals to neo-positivism, reductionism, instrumentalist thinking and naive empiricism in which "reality" is taken as a given (Pickles, 1995; Sheppard & Poiker, 1995).

The assumptions of this new science have been challenged in a number of recent critiques (Harley, 1989, 1991; Wood, 1992). Much of the criticism has focused on the geospatial data "community", a diverse group of individuals whose common interest is the development and application of geospatial technologies. These individuals are depicted primarily as technicians trained to push the right buttons in the right sequence in order to fulfill some programmatic mission. It is asserted that they rarely have to confront the ways in which different forms of representation affect communication (Miller, 1995). They are characterized as harboring the naive belief that reality is uncontested and objectively measurable (Harley, 1989). Most significantly, perhaps, members of this community are seen as unwilling or unable to accept the role that social and institutional values play in the representation of features in geospatial databases. It is asserted that these individuals, by failing to realize that geospatial databases embed the values of society at large and the specific institutions in which they are constructed, have promulgated the epistemological myth of the "cumulative progress of an objective science always producing better delineations of reality." (Harley, 1989, 15).

Users of geospatial technologies must of course be wary of aggrandizing the potential capabilities of these technologies, especially as this pertains to the inherent "truthfulness" of encoded data and derived cartographic products. At the same time there is an equally grave risk of assuming that because these individuals work in a technologically-infused environment they are concerned only with technique and not the larger social issues that inform their work. Users of geospatial databases cannot help but be aware of

the fact that there is no single "objective" representation of the external environment that is universally accepted. Like their manually- produced map counterparts, geospatial databases are not intended to be miniature replicas of the external environment. Rather they emphasize some aspects of the environment and suppress others in an effort to convey a particular message and argue for a particular viewpoint. What is contained in a database is a function not only of the nature of the external environment but also the values of the society and institution within which the database was constructed (Turnbull, 1989). Different values correspond to different attitudes about what aspects of the environment are important, and are responsible for the creation of different representations of the same geographic space. Values are embedded at various stages of database production through processes such as abstraction, classification and generalization. At the selection stage values impact database content (i.e., What feature classes and feature instances from the external environment are depicted?), while at the representation stage values impact database form (i.e., What geometric properties are employed in the depiction of a given feature class or feature instance?).

Content and form are manipulated by database producers to convey information in a specific way. The language of a geospatial database, as revealed through content and form, is usually tailored to a certain audience (e.g., geologists, soil scientists, etc.) who understand the language of the database just as they understand the jargon of their discipline. Different databases designed for different purposes show features in different ways, even if they cover the same geographic space and include many of the same features. Of course, the embedding of values is not always deliberate. The values particular to a given society at a given time are often taken for granted and are thus difficult to detect except in retrospect. The hierarchical social structure of eighteenth century Paris, for example, is made apparent cartographically when mansions are represented with symbols that maintain a rapport with what they represent while common homes are represented with a generic point identically reproduced in bulk (Harley, 1989). Because underlying values are often not consciously recognized, maps tend to reflect the social order and to reify and legitimate it. The rules of social order insert themselves into maps in a way that makes the map a commentary on the social structure of the place and time it was created (Harley, 1989).

These broad values form the backdrop for more specific values that reflect institutional characteristics. Institutional mandate is perhaps the most critical institutional characteristic that can affect database content and form. Broadly speaking, mandate defines institutional mission in terms of data collection and dissemination. For specific databases, mandate is formalized as a set of design guidelines that define the rules for data collection and encoding. These rules are especially important for large national mapping projects, where standardization is important, and for agencies that need to document their data collection and encoding processes for potentially contentious issues related to policy enforcement and litigation.

The broad social values inherent in databases may be inescapable and, to the extent that they are taken for granted, not easily documented. However, the values embedded in databases as a function of institutional characteristics can be articulated, documented and communicated to the database consumer. Indeed, producers of geospatial databases now rather routinely document these databases with metadata

that can be used by consumers to deduce some of the institutional values impacting the processes of data collection and encoding. This communication process is important since it affects the consumer's understanding of the limitations of a database and facilitates its appropriate use. The primary tools that have evolved to serve this communication process are derived from work on geospatial database quality. Geospatial database quality tends to be viewed rather broadly. It includes the concept of accuracy as a measure of conformance with an external standard, as in fields such as statistics and surveying, but it also includes factors such as resolution (e.g., What is the smallest area that can be mapped?), taxonomic fidelity (e.g., What is the degree of homogeneity in mapped classes?), consistency (e.g., Are any internal contradictions present?) and completeness (e.g., Does the database depict the features it purports to depict?). Many of these dimensions of data quality are included in the Spatial Data Transfer Standard (SDTS), recently adopted as a Federal Information Processing Standard (FIPS) by the National Institute of Standards and Technology.

Completeness is a useful concept in the context of the debate over values. Completeness refers to the relationship between the objects in a database and the abstract universe of all objects. The abstract universe is a reference standard against which the database is compared. Evaluation of completeness thus requires a formal description of both the database and the reference standard. Typically, the reference standard is related to a specific context and defined in accordance with a desired level of abstraction, such as a specific project objective (Brassel et al, 1995). From this standpoint, completeness is defined in terms of the intended contents of a database rather than some abstract and idealized "real world". Even small-scale, generalized databases can be complete (Veregin & Hargitai, 1995). Embedded in this definition of completeness is the notion of a reference standard that is relative rather than absolute. This definition recognizes that each database has a particular set of objectives and that these objectives are the formal expression of the values associated with mandate and other institutional factors. From this perspective, completeness measures the degree to which the objects encoded in the database are consistent with institution- defined design guidelines. The same relative reference standard is used, albeit less explicitly, in other data quality components as well. Indeed even the notion of accuracy is only meaningful with reference to the standard against which accuracy is assessed.

What are the implications for the current debate over values? First, it is an oversimplification to assert that geospatial databases are intended as mirrors of some objective and value-free "real world". Indeed from the standpoint of assessing data quality it is not even necessary to insist that such a world exists. Data quality and its various components, including accuracy, are relative measures in the sense that they are always measured against some imperfect reference standard. Second, it is an oversimplification to state that the geospatial data community is unaware of the significance of values. The reference standard itself is a formal statement of the values that are embedded in the database as a function of institutional mandate. Admittedly, broader social values are embedded in databases unconsciously and uncritically, but this is not necessarily a liability. After all, the ability of a database to communicate is dependent in some measure on its reliance on shared cultural values. Third, values can be articulated, documented

and communicated to geospatial database consumers using fairly simple tools. This suggests that consumers can assess the validity of a particular database for a given application as a function of database content and form. Knowledgeable map users have of course always been aware of the limitations of their data. In the digital era, increased reliance on secondary data sources means that the database consumer is more dependent on the particular biases present in the data source, which demands a more formal explication of these biases.

The ideas sketched above suggest that it is possible to account (to some degree at least) for the social construction of geographic space within a given institutional setting. This is an important conclusion, since the alternatives are not particularly useful for those who wish to continue to produce and use geospatial data. Some critics have claimed, for example, that given the dependence on social values it is really not possible to distinguish between competing representations of the same geographic space. Thus it has been argued that the artificial distinction between propaganda and truth must be dismantled, as must the arbitrary dualism between "art" and "science" (Harley, 1989). In short, all representations become equally valid since they are all simply expressions of one's personal values, or the values of one's culture, or the values of one's institution, any one of which has no more claim to legitimacy than any other. This anarchistic epistemology implies that we have no agreed-upon standard of reference, no way to argue for one representation over another, and no basis for communicating biases and assumptions. On the other hand, if databases are to be more than just personal artistic diversions, if they are to convey information rather than simply express the values and viewpoint of their creator, then they must rely on modes of representation that are meaningful across a spectrum of users.

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Introduction

Our 'GIS and Society' research is concerned with how socially differentiated geographic information can be produced and represented within a GIS, and the implications that arise for the variety of GIS receptors. In rural South Africa and industrial West Virginia, GIS are being developed which incorporate grassroots perspectives on natural resource access and techno-environmental risk. These GIS combine conventional socio-economic, environmental, and infrastructural data with non-conventional behavioral and cognitive information. A regional political ecology conceptual framework informs the GIS production process. The research is intended to contribute towards more democratic decision-making processes while also exploring the constraints and possibilities associated with alternative GIS production and use.

In both case study localities, a diversity of geographic information has historically been produced and consumed within a particular set of power relations. Kiepersol (South Africa) is a rural area with a long history of struggle over ownership and access to land, water and biomass resources. The apartheid regime forcibly removed of millions of African people in the geographical project of bantustan -- or "homeland" -- creation. In our research local knowledge about apartheid forced removals, agro-ecological potential, and access to land, biomass, and hydrological resources are used to complement more traditional top-down agency-driven data.

The Kanawha Valley, near Charleston (West Virginia), is one of the largest industrial chemical complexes in the world. In 'chemical valley', as it is known locally, the potential for environmental catastrophe combined with numerous more chronic health risks, are very much part of peoples' everyday lives. Risk management and access to information are, therefore, of major importance. Here the research focus includes an analysis of how people gain access to geographical information and how the representation of that information impacts the perception and management of risk. Specifically this includes investigating the ways in which the GIS production process transforms existing power relations and how access to chemical hazard information influences risk perception and management.

Research Design

The West Virginia and South Africa case studies are linked conceptually through (regional) political ecology. Political ecology is a diverse collection of theoretically informed case studies. Within geography, most political ecology research has been concerned with rural areas in peripheral regions, although some high quality research has been conducted in core regions as well. The relationship between rural relations of production and natural resource ownership, access, and use is a central political ecology theme. Land degradation is an important theme too. More recently, political ecology has broadened to include research on the cultural construction of nature, environmental hazards, epistemologies of environment, and new social movements.

Regional political ecology (RPE) is a useful conceptual framework for conducting "GIS and Society" field work. RPE is concerned with geographic scale and competition over environmental resources. In seeking to represent many, and often differing, representations of reality, the linking of RPE with GIS stimulates a number of important questions. This research employs a regional political ecology conceptual framework for GIS *production* which involves involves an analysis of how differing social groups construct and compete for natural resource and information access and how techno-environmental risks are perceived, spatially distributed, and socially regulated.

Objectives

Four broad objectives guide this research. They are:

- *To more fully understand how existing forms of geographic information influence natural resource access, property rights, and relations. We are concerned with the ways in which bio-physical resources are culturally constructed, politically contested and scale-dependent and the politics in which techno-environmental risks are assessed and 'managed.'.*

- *Analyzing how GIS incorporate multiple realities and competing representations of space and environment. This includes experimentation with multimedia GIS.*

- *Broadening the use of computer-based geographical information through a GIS production process that includes community participation. Of particular interest are the ways in which 'voices from below' are digitally represented and how socially differentiated local knowledge might be incorporated into GIS production and use.*

- *Examining how the introduction of GIS -- and other technological delivery systems of geographic information -- influence how and what decisions are made. This includes understanding the potential policy impacts of geographic information that displays conflicting representations of landscape. One expected outcome of this research is a better understanding of the opportunities for, and contradictions with, "democratizing GIS."*

The 'success' of GIS to date may be due in part to the belief in non-contradictory and 'objective' perceptions of reality. We examine in this research how a GIS containing potentially conflicting information from multiple sources is politically embedded and articulated within existing policy-making, politics, and institutions. In so doing we seek to contribute to the democratization of land use planning in South Africa and risk assessment and mitigation in West Virginia. Within the GIS, local resource utilization and land use practices are examined as politically contested and the product of processes operating at varying scales of analysis. The inclusion and representation of local knowledge in a digital form and the generation of meta-data are significant challenges to the GIS production process.

Methods

The research objectives articulated above necessitate an innovative and experimental research methodology. Our methodology builds on experimental research already completed and involves the integration of the following methods:

- a spatially encoded socio-economic survey

- intensive individual interviews

- participatory workshops

- transect walks and boundary identification with a GPS

- mental map construction

- classification and interpretation of remotely sensed data

- interactive multimedia - GIS linkages

- GIS digital encoding

In Kiepersol, the first phase of GIS database development included traditional environmental, physical and infrastructural data describing the human and physical geography of the area. The "Kiepersol GIS was developed with community participation and incorporates non-conventional behavioral and cognitive information associated with 'multiple realities' of highly contested rural territory. Data were derived from community workshops, individual surveys, and mental mapping exercises. To date we have experimented with mental mapping as a means of capturing local knowledge from socially differentiated groups. This has been based on the field interpretation of hard copy topographic 1:50,000 scale maps. Base maps for use in conjunction with GPS capability in the field, will be generated from the GIS to support the mental map generation and field survey work. Our intent is to develop culture-sensitive approaches to data capture and digital representation which do not place as great a dependency on Euclidean or 'First-World' interpretations of space.

In the Kanawha Valley, we are exploring the definitions, perceptions, responses, and mediations of risk associated with the four social categories of capital, labor, community, and the state. An epidemiological component of the research focuses on health risks and the spatial distribution of cancer clusters. Multiple representations of information are essential to such a pursuit. Local knowledge from the community will be obtained through mental maps, oral histories, and workshops within an ethnographic methodological framework. So-called 'expert' knowledge will be obtained from existing spatial information and environmental legislation and regulations as well as primary data collection from persons associated with the (local) state and capital.

Participatory workshops will be a central method for incorporating local knowledge into the GIS production process. Two sets of workshops will be held during the course of the project in each of the areas where interviews take place. In Kiepersol, these involve large-scale commercial farms; farmworker compounds; and the within bantustans. The first set of workshops will introduce communities to the project and involve a mental mapping exercise. They will also provide a context to discuss the quantitative and qualitative research. The difficult process of conceptualizing social differentiation in rural South Africa will draw upon previous research undertaken. In bantustan workshops, participants will be divided into groups on the basis of their gender and access to agricultural land. Four groups will be established: women with land; women without land; men with land; men without land. Chiefs and their patrons will constitute a fifth group which will be interviewed separately and in a different time and place. The area has a history of bitter conflict between some residents and the institution of the chieftaincy. These five groups will construct resource and resource access mental maps of the area.

Capturing and encoding local knowledge, which is often aspatial and qualitative, represents a significant challenge to GIS production. From our work to date we are aware that much local knowledge is spatially fuzzy and does not conform easily to the spatial primitive paradigm of point, line, and polygon employed by

GIS. Oral histories and narrative provide some of the most compelling and informative knowledge to come from the interview-survey process. Not least, the anticipated variety, and possibly conflicting responses, from the socially differentiated groups will provide additional complications for incorporation within the GIS. Cognitive maps, for example, deal with the spatial information about an environment and encompass internalized perceptions of knowledge and experience. Cognitive mapping functions can be divided into cognitive maps which are based on routes and involve judgments about location, direction, or distance; cognitive collages, which are like thematic overlays of multimedia from differing perspectives; and spatial mental models which represent the relations among different elements. These views of cognitive mapping appear to support Golledge's description of cognitive maps as 'internalized GIS'. Cognitive maps generated from route learning are different from those obtained from map reading. This project utilizes both approaches in the form of tracing paper overlaid over local 1:50,000 topographic maps and GIS produced shaded relief maps, and boundary-transect walks utilizing GPS. More accurate judgments for map-based mental map construction can be obtained by an iterative process in which explanation, questioning, and field walks are included in the mental map production process.

The development of GIS-interactive multimedia (IM) linkages promise to advance current GIS capabilities considerably. In order to include the variety of narratives, oral histories, anecdotal information, sound, text, photographs, sketches, maps, and video clips which are the tangible materials of local knowledge, we seek to develop icon-driven capabilities within the GIS-IM system to access the full range of traditional and local knowledge available for interpretation. The many relationships between geographical location, data, and the several media modes will be established using an authoring system. Data inquiries will be handled using 'hot link' icons from the GIS based on the hypertext concept. This model describes a set of nodes connected by undifferentiated links, where the nodes can be abstractions made up from any kind of text or graphical information elements. The nodes and the associations between them, the links, form semantic units which may express a single idea or simple data element, or a complex unit such as a map, table, or image. The links tie together the various semantic units and provide a means of navigating through the data.

The development of Hypermaps moves beyond the establishment of links between semantic nodes to include links between spatial location and nodes. The ability of GIS to undertake spatial search functions would be linked to the identification of multiple media objects found within the search parameters. Once identified these objects can be retrieved, displayed, or used as signposts to other sources of information contained within the GIS or multimedia database. This logical movement through the information base utilizes the power of GIS and the flexible nature of multimedia to incorporate information in various media. While these linkages will provide significant freedom to explore the informational relationships contained in the database, one of the main issues involved in the design of these systems revolves around the actual organization, management, and content of these nodes and links within the computer environment.

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[i]The South Africa component of the research is being conducted in collaboration with Tim Warner (West Virginia University) and Richard Levin (University of the Witwatersrand, Johannesburg).