

PART I

# Introduction







# Geographic Information Systems and Society: A Twenty Year Research Perspective

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## **GIS AND SOCIETY RESEARCH WITHIN THE BROADER CONTEXT**

‘Society’, in the general sense of the term, means ‘a community, nation, or broad grouping of people having common traditions, institutions, and collective activities and interests, or more specifically an enduring and cooperating social group whose members have developed organized patterns of relationships through interaction with one another’ (*Merriam-Webster Dictionary*, online edition); a heady concept indeed! So what does ‘society’ have to do with a technology such as geographic information systems (GIS), and what kinds of research linking these two notions does the title of this handbook imply? The 27 chapters in this book address many facets of those questions. Basically, the overarching theme in GIS and society research is how this technology influences, and is influenced by, the various structures, processes, mechanisms

and events that characterize today’s post-industrial societies. A simpler way of expressing this may be to ask how geographic information technologies affect people and organizations and, conversely, how people and organizations use the technology and by using it, cause it to change. This question is of course part of the broader one concerning the relations between society and information technologies in general. However, geographic information technologies have unique characteristics that suggest a societal problematic of their own. The purpose of this book is to help unpack that problematic from a range of different perspectives that owe as much to the personal societal interests of the chapter authors as to their individual areas of technical expertise. The result is a broad panorama of GIS and society research that is neither complete nor the only one possible, but one that conveys a strong sense of the breadth and depth of the domain in question.

None of this was part of the picture some 40 or 50 years ago, when GIS was emerging out of the nascent fields of computer cartography, spatial statistics and analysis, and computer science. GIS research at that time was highly technical, much of it focused on algorithm development and map production. The early operational systems were primitive, with only those individuals in a select geospatial 'priesthood' able to contribute to, and actually work with them. The research community, focused on solving practical problems, had little idea of how these systems would evolve and mature, and little thought was given to the potential connections with society of the simple software packages of the day. Before too long however the impact of that novel kind of software was felt in a host of disciplines from demography to transportation planning to natural resource assessment, and it became increasingly clear that decisions made with the help of that software would have significant and long-lasting effects on many sectors of society. Indeed, by the 1980s and early 1990s GIS was beginning to be widely adopted by governments, businesses, and other kinds of organizations to address a wide variety of complex natural, social, and infrastructure issues. To the extent that society has a stake in these issues it soon became evident that the increasingly powerful software systems designed to help perform sophisticated analyses and to support significant decisions in these areas were having considerable and often unequal effects on different social groups. The field of GIS and society research was born out of this growing realization.

### THE EARLY GIS AND SOCIETY DEBATES

What started as a gentle exchange between geographic information scientists and critical human geographers in the very early 1990s progressed to a full-scale controversy

by the middle of that decade. A deciding moment came in the fall of 1993 when a group of researchers on both sides of the already heated debate came together in Friday Harbor, Washington, in an attempt to find some common intellectual ground for moving forward. From these discussions a robust research program in GIS and society eventually emerged that progressed in several different directions. Conferences and workshops, many sponsored by the National Center for Geographic Information and Analysis (NCGIA), which continued as the Varenus Project in the late 1990s, addressed a variety of GIS and society issues. Notable among these workshops was the NCGIA-sponsored Specialist Meeting held in Minnesota in 1996, where the concept of an alternative model for GIS was discussed, one that would not be constrained by the rigid geometrical paradigms of traditional GIS, and would thus be able to accommodate alternative ways of representing space and spatial processes. This was in response to a growing concern that stakeholder groups in society, especially those already marginalized, were being left out of a discourse that increasingly relied on GIS analyses too technical for non-experts to comprehend. There was already evidence that GIS was empowering certain segments of society and privileging certain groups and communities at the expense of others. Participants also espoused the view, by then well established in social theory, that different social groups outside the mainstream may have different conceptions of space and socio-spatial reality. GIS II, as this new model became known, was eventually operationalized as public participation GIS (PPGIS), although some argued that 'community-based GIS' was a better name. Some of the core concepts and debates from these early efforts were published in a special issue of *Cartography and GIS* (CaGIS) in 1995 (Sheppard and Poiker, 1995) and in the edited volume *Ground Truth* (Pickles, 1995). Other notable meetings and publications from that period and beyond are listed

in Appendix A (at the end of this chapter). Each of the three editors of this Handbook took part in several of these meetings, sometimes as co-organizer, including the critical Friday Harbor and Minnesota workshops that are credited with initiating and broadening the exploration of GIS and society research.

Thus, initially, much of the motivation for research on the relations between GIS and society came from critics of GIS technology, resulting in a highly polarized view of these relations. On the one hand, GIS enthusiasts saw the technology as a force for good, stressing its role in enhancing scientific knowledge about the geographic world, human as well as natural, and in improving the quality of related decisions. On the other hand, there were those who were highly critical of GIS, seeing it as yet another technology leading to the 'colonization' of everyday lives, a technology with enormous potential to render people more locatable, traceable, objectified, and geo-coded, making them the 'geo-slaves' of a new 'governmentality'. These latter arguments fall within the broader critiques of Western philosophy, of masculinist perspectives in science, and of capitalist and neoliberal political economies, all of which purportedly conspire to demand a more 'visible' social (and sometimes also natural) world. There is no denying that GIS and related technologies provide extensive capabilities for surveillance and for tracking individual data-trails. The fear that 'big brother is watching us' is very real for many people. The thousands of video cameras monitoring automobile and pedestrian traffic in London and in other major cities around the world may be seen as the electronic eyes of sinister police departments, or as life-saving devices that help catch those who bomb trains.

The debate about the 'good' and 'evil' sides of geographic information technologies continues to this day, though in a much more qualified form. The naivety of sharply polarized thinking begins to unravel quite readily once one begins more fully to research,

deconstruct, and reconstruct the relationships at play. Simplistic perspectives on either side of the debate are being superseded by an understanding that the intents and actions of agents need to be situated within their social and institutional contexts in order for GIS technology development and use to be judged as good or evil. This more mature stance is part of a growing interest in creating an intellectual foundation for approaching the development and use of GIS as being itself a complex societal process.

## GIS AND SOCIETY RESEARCH IN THE 2000S

As the discussions, debates, and engagements evolved and the research literature grew, a broad consensus eventually emerged regarding the relationship between GIS and society. In the meantime, geographic information *science* had emerged as the theoretical framework for geographic information systems (Goodchild, 1992), and conditions were ripe for a more systematic approach to GIS and society research. In 2004, a major report entitled *A Research Agenda for Geographic Information Science* (Elmes et al., 2004), written by delegates of the University Consortium for Geographic Information Science (UCGIS – <http://www.ucgis.org>), proposed that research on GIS and society should consider the following broad questions.

- In what ways have particular logics and visualization techniques, value systems, forms of reasoning, and ways of understanding the world been incorporated into existing GIS techniques, and in what ways do alternative forms of representation remain to be explored and incorporated?
- How has the proliferation and dissemination of databases associated with GIS, as well as differential access to these databases, influenced the ability of different social groups to utilize this information for their own empowerment?
- How can the knowledge, needs, desires, and hopes of non-involved social groups adequately

be represented in a decision-making process, and what are the possibilities and limitations of GIS technology as a way of encoding and using such representations?

The UCGIS report (Elmes et al., 2004) also proposed a formal classification of the research activity in GIS and society under five different approaches or perspectives, as follows.

### ***Approach 1: The critical social theory perspective***

This perspective continues and updates the original critical social theory interest in issues of marginalization and empowerment, access, surveillance, and other issues of social equity. It is concerned, among other things, with the limitations of current GIS representations of populations, locational conflicts, resource distributions, and other essential aspects of social geographies, and with the extent to which these limitations can be overcome by enhancing the capabilities of geographic information technologies. It is also concerned with how the evolution of geographic information technologies reflects both the societal structures and priorities as well as the practices of those who develop and utilize them, and with the more troubling question of whether the use of geographic information systems and other geospatial technologies actually benefits society (McMaster and Harvey, 2010). Another significant theme within the critical social theory perspective is that of data confidentiality. As pointed out in a recent National Research Council (NRC 2007) study on the subject, 'The increased availability of spatial information, the increasing knowledge of how to perform sophisticated scientific analyses using it, and the growth of a body of science that makes use of these data and analyses to study important social, economic, environmental, spatial, and public health problems has led to an increase in the collection and preservation of these data and in the linkage of spatial and

non spatial information about the same research subjects' (2007: vii). This issue is clearly of growing import as the spatial data in question become more accessible and ubiquitous, and the technologies that may be used to extract sensitive information from them becomes more powerful.

### ***Approach 2: The institutional perspective***

This perspective is concerned with the implementation of GIS within institutions, and more specifically with the costs and benefits associated with that implementation, the equity of the distribution of these costs and benefits among individuals and social groups, and the ongoing coordination and maintenance of geographic data by institutions. The institutional perspective also focuses on the development of theories, tools, and techniques for determining the impact of GIS on policy decisions, on how interactions between agencies and between citizens and government agencies are affected by the use of GIS, and on the technology's impacts on people's beliefs and actions in regard to the use and management of the land.

### ***Approach 3: The legal and ethical perspective***

This perspective is concerned with the institutional processes and pricing mechanisms governing access to spatial data, with the proliferation of proprietary spatial databases, with how these changes are rooted in governmental and legal regulation, with the ethical implications of these changes, and with possible legal remedies to related problems. Some argue that these two topics – legal issues and ethics – should not be coupled as each has a distinct history and relationship to GIS. For instance, in response to the proliferation of spatial databases, in particular those used for land and public records, a special branch of spatial law has developed.

A critical question here deals with the ownership and accuracy of these data. Distinct from the legal concerns with spatial data are ethical debates surrounding their acquisition, use, and digital representation. For instance, as the spatial resolution of remote sensing imagery becomes finer, now commonly one meter or less, new ethical issues arise relating to privacy and surveillance. The use of geospatial technologies for tracking people also raises deep ethical questions. The Urban and Regional Systems Association (URISA) has now developed a Code of Ethics (<http://www.urisa.org/about/ethics>) to help GIS professionals make appropriate and ethical choices. The ethics code consists of four primary categories: obligations to society; obligations to employers and funders; obligations to colleagues and the profession; and obligations to individuals in society.

#### ***Approach 4: The intellectual history perspective***

This is the fourth approach to understanding GIS and Society research, and it is concerned with tracing the evolution of geographic information technologies, the dynamics through which dominant technologies are selected out of a variety of potential alternatives at critical points in time, the societal, institutional and personal influences governing these selection processes, and the question of whether and why other promising alternative technologies may have been overlooked. Some have argued that much of what makes up geographic information technology today resulted from research and development in the military-industrial complex (McMaster and Harvey, 2010). Others however can point to significant contributions by the private and governmental sectors, noting that the concept of topology as used in spatial databases comes out of the careful work of the United States Census in the 1970s within the context of building digital files of census units. This, and the work of the Harvard Laboratory for Computer

Graphics and Spatial Analysis, institutionalized this particular data model (what eventually became the dominant georelational model) over other possibilities.

#### ***Approach 5: The public participation perspective***

This final perspective identified in the UCGIS report (Elmes et al., 2004) is concerned with how a broader effective use of GIS by the general public and by community and grassroots groups can be attained, with implications for the empowerment of such groups as partners in discourses concerning their interests and rights. McMaster and Harvey (2010) identify a set of core questions that have emerged in public participation research.

- What technologies are most appropriate for community groups? How is the needed technological expertise maintained in communities? How do community groups gain access to the appropriate data?
- What models of access to the technologies are most appropriate?
- What are the methods of localized knowledge acquisition that are most appropriate?
- How may these technologies fundamentally change the political/social structures of community groups?
- What forms, including new forms, of representation are best suited for public participation work?
- How do neighborhood groups deal with issues of scale (e.g., relationships with municipal and state regulations)?

Some of the initial work in PPGIS identified a series of models by which the public could gain access to spatial data and digital maps (Leitner et al., 2000). Each of these models, which included

Community-based (in-house) GIS, University/Community Partnerships, GIS facilities in universities and public libraries, 'Map Rooms', Internet map servers, and Neighborhood GIS centers, has its own advantages and disadvantages. The one model that has dominated the PPGIS landscape is the Internet map server. Such servers have been

developed at many scales, from the local (community-based mapping systems down to the neighborhood level) to the state level (e.g., sites displaying information on the distribution of natural resources), to global-scale sites built on universal resources such as Google Earth. (McMaster and Harvey, 2010)

## ADDITIONAL PERSPECTIVES ON GIS AND SOCIETY

Following the perspectives directly addressing GIS and society connections, views about the nature of the technology itself have evolved over the years, making its socially relevant role part of its definition. In the late 1980s, a group of researchers, software industry experts, and US federal agency personnel developed a definition for GIS as a combination of hardware, software, data, people, procedures, and institutional arrangements for collecting, storing, manipulating, analyzing, and displaying information about spatially distributed phenomena for the purpose of inventory, decision making and/or problem solving within operations, management, and strategic contexts (Dueker and Kjerne, 1989). Three perspectives are represented within that definition, each providing a way to understand the societal dimensions of GIS (Nyerges, 1993). The first perspective views GIS as a system of components that include not just machines and data but also people and institutions. The second perspective addresses the processes involved in the use of the technology, making clear that the purpose of GIS is not mere data handling but the representation of spatially distributed phenomena, which are as often societal as they are natural or combined. The third perspective focuses on the practical applications of GIS in decision making, management, and so on, as used by governments, businesses, research, NGOs and not-for-profit organizations, as well as by community groups. That complex definition thus clarifies ‘from the inside out’ how GIS connects with society in what it is, what it does, and for what purposes it does it.

As the breadth and depth of societally relevant applications grew over time, many researchers felt that the ‘S’ in GIS could legitimately be interpreted as ‘services’ as well as ‘systems’. This view became more prevalent in the late 1990s when new developments of hardware and software associated with the expansion of the Internet gave a strong boost to the practical applications of GIS. The new technical possibilities for remote service delivery generated further interest in the potential of the technology to serve societal needs, and many more academic disciplines and segments of society were able to capitalize on the benefits of map use, which had by now become much more accessible to non-experts. As mentioned earlier, around the same time the field of GIS had sufficiently matured as an intellectual endeavor to fully justify another interpretation of the acronym as Geographic Information *Science* (Goodchild, 1992). Not coincidentally, a large part of geographic information science today focuses on the societal dimensions of the technology. These three perspectives on GIS – as systems, as services, and especially as science – are amply illustrated in the research presented in this volume.

Today most research in GIS and Society directly or indirectly touches on all three aspects of GIS as science, systems, and services. While distinct, these three perspectives build on each other: technical system developments affect practice, practice in turn identifies system shortcomings that need to be addressed, and basic research analyzes, anticipates, and provides new conceptual frameworks for approaching issues that emerge in both of these areas. This makes for a very broad umbrella under which computer scientists and mathematicians, social scientist, and geographers of every stripe, cognitive scientists, legal experts, philosophers, and academic activists can all find research themes to suit their interests and skills. It is no wonder that research relating to geographic information technologies is blossoming. By necessity the material in this

Handbook tends to emphasize the conceptual aspects of GIS research over the practical or technical ones, even though empirical research around case studies, or research fostering needed technological advances, may be just as valuable.

## STRUCTURE OF THE HANDBOOK

Based on their first-hand experience of more than 20 years of research in geographic information and society, the Handbook editors identified a tentative list of major themes and potential chapter titles and chose the prospective US and international chapter authors accordingly. Appendix A lists the major meetings and publications that influenced these choices. As the chapters came in we were gratified to see that even though most authors had provided their own titles, the chapters still fell neatly into six broad categories that were very close to the ones we had anticipated. Even more importantly, these themes, and particularly the topics within the themes show considerable continuing research potential. It also appeared that a few topics were no longer considered as important as they had been a few years earlier, while other concerns or interpretations were emerging or becoming more prominent. The Handbook thus represents a snapshot in time, which is as it should be for a field as dynamic as that of GIS and Society research.

The themes that constitute the six sections of the Handbook are as follows:

- 1 Foundations of GIS and Society Research
- 2 GIS and Modern Life
- 3 Alternative Representations in GIS and Society
- 4 GIS in Organizations and Institutions
- 5 GIS in Public Participation and Community Development
- 6 Value, Fairness and Privacy in a GIS Context

Below we provide an overview of these sections and the respective chapters within each, starting with foundational issues in

Section 1 and ending in Section 6 with considerations of value, fairness, and privacy as relating to geographic information. This sequence may be seen as a progression from topics that are basic to an understanding of the socio-spatial world to issues that deeply affect individuals and groups as members of society.

### ***Section 1: Foundations of GIS and society research***

Four chapters compose this section. We start with Chapter 2, 'Concepts, Principles, Tools, and Challenges in Spatially Integrated Social Science' by Donald Janelle and Michael Goodchild. Researchers in the social sciences beyond geography have been discovering the advantages of considering spatial location in the explanation of social relationships, leading to the notion that space acts as a strong integrative element for the social sciences. Spatially integrated social science deals with the growing understanding of how most of the social sciences connect with geospatial perspectives. Research is underway to explore the changing significance in the information age of key geographical concepts as applied to non-spatial social sciences and as reflected in the evolving character of GIS. Next, in Chapter 3, entitled 'Geographic Ontologies and Society', Marinos Kavouras and Margarita Kokla report on how the development of geographic ontologies has emerged as a fundamental research interest. Ontologies for fundamental spatial concepts can affect our interpretations of the world as seen through the prism of GIS. The linkage of spatial concepts with the technologies for processing, analyzing and displaying georeferenced information is seen as an important objective to enhance social science insight for understanding and solving critical scientific and societal problems. The third chapter in the section, Chapter 4, entitled 'The Social Potential of GIS' is by Stacy Warren. Warren explores how GIS increasingly shapes society and in turn how society

shapes what is important in GIS. The meaning of information in a socially constructed world deals with identity of place as relates to power relations of place, and of course the two issues are related. When seen as part of an assemblage grounded in a longer trajectory of participatory technologies constructed and transformed through mass-mediated, globalizing economies, GIS clearly embodies the social potentials and social perils of the contemporary social dialectic. Last in this section is Chapter 5, entitled 'Critical GIS' by Sarah Elwood, Nadine Schuurman, and Matthew Wilson. The chapter situates critical GIS amid the GIS and society tradition, and points to new modes of GIS practice that have emerged under the banner of critical GIS, including participatory, qualitative, and feminist GIS. Chapter 5 also traces the theoretical and epistemological bases of qualitative GIS, and shows how critical GIS scholarship demands an expanded understanding of the ways of knowing and producing knowledge that are possible with GIS. Finally, the chapter considers newly emerging spatial technologies, forms of geographic information, and modes of visualization that expand conventional forms of GIS and spatial data, and identify key questions that must be asked of all phenomena as critical GIS research enters its second decade.

### **Section 2: GIS and modern life**

Four chapters also compose Section 2. The first, Chapter 6, entitled 'Connecting Geospatial Information to Society through Cyberinfrastructure' is by Marc Armstrong, Timothy Nyerges, Shaowen Wang, and Dawn Wright. The Internet and World Wide Web have had a tremendous impact on society over the past 15 years, providing unimagined access to information. More recently, new types of software are being developed that are combined with advanced hardware to create a new type of infrastructure called *cyberinfrastructure*, now one of the most important utilities that people have come to

rely upon in the developed world. A recounting of this recent phenomenon is presented along with some critical perspectives about the social dilemmas we could face as society continues to connect online. The next chapter, Chapter 7, entitled 'Environmental Sustainability: The Role of Geographic Information Science and Spatial Data Infrastructure in the Integration of People and Nature', is by Clodoveu A. Davis, Jr, Frederico T. Fonseca, and Gilberto Camara, and provides an additional perspective on data within the cyberworld. However, this time, the focus is on how to bring the study of people and nature back together through spatial data infrastructures. Perspectives that connect people to nature are critical to understanding the relationships between humans and environmental sustainability. Several research questions are examined addressing the ways in which such integrative perspectives may be developed through access to spatial data infrastructures. Chapter 8, by Nadine Schuurman and Nathaniel Bell, is entitled 'GIScience and Population Health: An Overview'. Population health has always been an important research topic, but in the 21st century it could become one of the most important emerging research areas in GIS. The locational and environmental dimensions of health must be considered together with more traditional approaches dealing with how people can become and stay healthy as well as with the threats to health. The chapter presents a population health model and the primary techniques used to quantify and provide empirical evidence of geographic variations in health. It considers emergent GIS approaches for conceptualizing neighborhood influences on health, and for quantifying such relationships. The last chapter in this section, Chapter 9 entitled 'Cogito Ergo Mobilis Sum: The Impact of Location-based Services on Our Mobile Lives', is by Martin Raubal. Locational services and associated technologies are now rapidly expanding across the world. Next to providing valuable information on the users' surrounding areas, such technologies support

the collection of information about the movements of individuals and vehicles and in turn seem to encourage further mobility. Location-based services show considerable potential for growth, but they also raise some difficult societal issues such as the threat to privacy.

### **Section 3: Alternative representations of GIS and society**

Section 3 consists of four chapters exhibiting a high diversity of views as they explore previous research and point to directions forward. The first chapter is Chapter 10, 'Human-scaled Visualizations and Society', written by Dimitris Ballas and Danny Dorling. The authors identify the predominant trends in visualizing social phenomena using area-based cartograms and discuss how it is possible to tackle with this particular visualization method some of the problems associated with traditional cartographic approaches. They show how cartograms can be used to create maps of the world, with each country re-sized in proportion to some variable of interest (e.g., population, income, or unemployment rates). The chapter also discusses the societal implications of decisions to adopt a particular mapping and visualization method. The next chapter, Chapter 11 entitled 'Indigenous People's Issues and Indigenous Uses of GIS' is by Melinda Laituri. Laituri describes the state of the art in this domain, highlighting the politics of representation as a crucial aspect of the praxis for identifying and discussing how projects are conceptualized and implemented in indigenous communities. Geospatial technologies have been used by indigenous peoples for a variety of purposes including creating land tenure maps, managing natural resources, mapping cultural heritage, and for economic development. The chapter examines the role of online technology and its relationship to the presentation and dissemination of indigenous information. Various websites representing indigenous knowledge

explore how science and local culture may be intertwined for resource management and for local expression of empowerment. The third chapter in this section, Chapter 12, is entitled 'Spatial Modeling of Social Networks' and is co-authored by Carter Butts and Ryan Acton. Virtual social networks – on-line systems composed of social entities and the relationships among them – are 'spatialized', that is, given a spatial dimension, to help understand the role of space in the formation and strength of social relations supported on the internet. The authors review the core network terminology and concepts, the special data considerations for spatially embedded networks, and provide an overview of specification and estimation issues pertinent to the spatial modeling of network data. As a case study, Butts and Acton examine communication breakdowns that occurred following hurricane Katrina in 2005 on the US Gulf Coast. Lending a spatial dimension to communications networks fosters deeper understanding of social connections and reveals gaps in information flows. The last chapter in this section, Chapter 13, is 'GIS Designs for Studying Human Activities in a Space-time Context', by Hongbo Yu and Shih-Lung Shaw. Yu and Shaw describe how time geography offers an elegant framework for studying individual activities and their relationships in space-time contexts. Although early studies used time geography mainly as a conceptual framework, more recent developments in GIS demonstrate opportunities for implementing the framework, applying it to various social domains. Overviews of time geography, of major temporal GIS designs, and of GIS models for spatio-temporal activities are also included in the chapter. A space-time GIS design, which uses a 3D (i.e., 2D space + 1D time) GIS environment to simulate the integrated space-time system of time geography, is introduced. That design enables a 3D representation and visualization of space-time paths and prisms, and supports the spatiotemporal analysis of activities. Future research challenges are also discussed in the chapter.

#### ***Section 4: GIS in organizations and institutions***

The fourth section focuses on the role of GIS within organizations and institutions. The first chapter of this section, Chapter 14: 'Emerging Frameworks in the Information Age: the Spatial Data Infrastructure Phenomenon', is by Ian Masser. The chapter reviews developments in spatial data infrastructures and examines some of the broader issues emerging from them. Three significant topics are: the concepts that underlie the spatial data infrastructure (SDI), the methods and organizational structures needed to facilitate SDI implementation, and issues concerning SDI applications at sub-national, national and supranational levels. The chapter also suggests future research directions that emerge from these issues. The second chapter in this section, Chapter 15, is 'Spatial Data Infrastructure for Cadastres: Foundations and Challenges', by Francis Harvey. Data about land ownership – the cadastre data – are among the basic elements of a SDI. Cadastral information is typically of major importance because it connects rights, restrictions, and responsibilities to land parcels and is used for taxation in most countries around the world. It also often provides crucial ancillary information for government and private activities such as for flood abatement districts, soil protection areas, and countless more. By its nature the cadastre serves conflicting interests, which a SDI needs to continue to support through the corresponding re-visioning of the notion of cadastre. This chapter reviews four examples to point out these challenges and the range of strategies for integration with SDI concepts. The third chapter, Chapter 16, is entitled 'GIS-based Computer-supported Collaborative Work Flow Systems in Urban Planning', and is written by Anthony Yeh and Kenneth S.S. Tang. Yeh and Tang describe how GIS-based planning support systems enable information flow within a planning office. They focus on how decisions on development control are made as well as on the collection of public

comments on planning applications and the dissemination of both textual and graphical information to the public at various stages of the planning process. The integration of a workflow system with planning support systems facilitate the tracking of progress at different stages in the decision making process of development control. A case study on the application of a collaborative workflow system integrated with GIS developed by the Hong Kong Planning Department is used to show how an integrated system can be used to enhance development control and public consultation. The final chapter in this section, Chapter 17, is 'GIS and Emergency Management' and is written by Christopher T. Emrich, Susan L. Cutter, and Paul J. Wechsler. This chapter describes applications of GIS for emergency management. Current and future developments in geospatial technology promise to increase the use of geographic data and techniques in disaster response and recovery to save lives, protect property, and reduce the economic impacts of hazards. The chapter has four major sections that parallel the four tenets of the emergency management cycle, identifying and explaining GIS functions and capabilities within each of these four main steps. Future directions are outlined for both research and practice.

#### ***Section 5: GIS in Public Participation and Community Development***

The fifth section begins with Piotr Jankowski's 'Designing Participatory Geographic Information Systems', (Chapter 18). Jankowski describes the conceptual bases for system design that derive from the notion of communicative rationality exemplified by a deliberative-analytic model of public participation. A framework called Enhanced Adaptive Structuration Theory helps with systematically considering the characteristics of anticipated participants, the process flow, and the interaction between technology and people. The chapter discusses fundamental

Public Participation GIS (PPGIS) design considerations including participant information needs and the relationship between group size, participation setting, and information technologies. The chapter closes with pointing out opportunities and challenges for future PPGIS designs leveraging the widespread public familiarity with digital globes and the novel phenomenon of volunteered geographic information (VGI). The second chapter, Chapter 19, is 'Online Public Participation GIS for Spatial Planning', by Richard Kingston. Based on past research the chapter highlights where online PPGIS works best, drawing out the key strengths, weaknesses, opportunities, and challenges that the approach offers. The chapter proceeds to discuss issues in relation to e-government and the dilemma around the notions of the active citizen and the consumer citizen. It suggests that PPGIS is one possible approach that helps to unpack the theories and assumptions about e-government into a practical solution that allows active citizens to contribute and participate in spatial decision making in their locality of interest while also fulfilling the transparency and efficiency requirements of good decision making. The third chapter is entitled 'Participatory Approaches in GIS and Society Research: Foundations, Practices, and Future Directions', Chapter 20, and is written by Sarah Elwood. Elwood frames participatory approaches in GIS and society research as encompassing substantive and methodological engagements with the related perspectives of participation in grass-roots GIS research, participatory in action research that incorporates GIS, in group decision and collaborative GIS research. The chapter explores the range of ways in which GIS and society research has engaged theories and practices of participation, in these realms. It situates the epistemological and political roots of participation in GIS and society research within feminist critiques of science and pragmatist philosophies of knowledge. It reviews the range of ways in which GIS and society researchers have studied and practiced participation, reflecting on

the key contributions and limitations of these different approaches. Finally, it considers future questions for GIS and society research in this arena, with a particular focus on emerging spatial technologies that are transforming the possibilities and challenges of facilitating collaboration in the creation and sharing of spatial knowledge. The fourth chapter, Chapter 21, is 'PPGIS Implementation and the Transformation of US Planning Practice', by Laxmi Ramasubramanian. The chapter reflects on the changing nature of planning practice in the USA, arguing that the use of geospatial technologies can help make day-to-day planning practice more efficient, inclusive, transparent and accountable only when coupled with credible participatory processes. Ramasubramanian describes the synergistic relationship between successful technology adoption and use by community groups, and changes in conventional planning practices in the USA. Ramasubramanian presents preliminary evidence that PPGIS developments have encouraged both citizen and official planners to use consensus-building approaches and pragmatic problem solving strategies. The last chapter in the section, Chapter 22 entitled 'Politics and Power in Participation and GIS Use for Community Decision Making', is by Rina Ghose. This chapter describes how spatial knowledge produced through bottom-up PPGIS can greatly assist community organizations to navigate the complexities of collaborative governance. The chapter draws upon the literature on urban geography, planning, and PPGIS, and the author's decade-long investigation of PPGIS activities in inner-city Milwaukee. Ghose explores how internal organizational factors shape the abilities of community organizations, leading to some being more successful than others in affirming their rights and obtaining resources in order to transform 'spaces of despair' into 'spaces of hope'. The chapter examines the critical role of actors and networks that shapes the PPGIS process and discusses the internal characteristics of community organizations that significantly affect their abilities

to undertake PPGIS activities to negotiate better conditions for themselves.

### ***Section 6: Value, fairness, and privacy in a GIS context***

In the sixth and last themed section, several chapters focus on research concerning issues of Value, Fairness, and Privacy relating to GIS use. The first chapter in this section is Chapter 23 'Geographic Information Value Assessment' and is written by Roger Longhorn. As SDI initiatives are emerging and being implemented around the world, funding agencies need to understand the value that related expenditures bring to their governments, societies, and economies. Geographic information is at the heart of all SDIs, yet quantifying the value of geographic information is problematic. The chapter explores several viewpoints, including what is meant by the term 'geographic information', how to determine its value, how to put a value on data tied to concrete locations, issues of value chains, and what further research may be needed in this area. The second chapter, Chapter 24 entitled 'Geovisualization of Spatial Equity', is written by Emily Talen. Traditionally, spatial equity has fundamentally been about access to people, services, and resources. The visualization of varying patterns of physical access currently helps characterize the degree of spatial equity, but an emerging information-age view sees spatial equity as being redefined in terms of the transactions that may take place in virtual as well as in physical space. When spatial equity is more widely defined as the equitably distributed ability to access either physically or virtually particular goods, services, or facilities, then, Talen argues, the visualization of spatial equity opens up a wider range of conceptual and methodological issues. The third chapter, Chapter 25, is 'Natural Resource Conflicts, their Management and GIS Applications', by Peter Kyem. The chapter explores how applications of a data-driven technology such

as GIS can influence decisions that stakeholders make to resolve or prolong a conflict. The chapter presents an overview of the role that GIS plays in the management of resource conflicts, starting with a discussion of their causes and consequences. That is followed by a review of theories on conflict and GIS applications. GIS-based decision support techniques for managing conflicts are then reviewed. The technology's contribution to the decision making process is explained. The chapter concludes with an assessment of the role of GIS in conflict management. The fourth and last chapter of this section, Chapter 26, is entitled 'Legal and Ethical Issues of Using Geospatial Technologies in Society' and is written by Daniel Sui. Society has greatly benefited from the diverse applications of geospatial technology, but the latter has also raised a host of legal and ethical issues at individual, institutional, and international levels. The chapter provides an overview of the legal and ethical issues associated with GIS in connection with privacy, intellectual property, and national sovereignty. Legislative, ethical, and technical approaches to tackling these issues are also treated. To move beyond these challenges, a broader discussion must take place among geographic information scientists, geographers, and legal scholars who are interested in the ethical and legal issues arising in the age of ubiquitous computing.

Finally, the last chapter of the Handbook is entitled 'GIS and Society Research: Reflections and Emerging Themes' and is written by the editors Helen Couclelis, Timothy Nyerges, and Robert McMaster. In the last chapter the editors reflect on the major issues, debates, and trends in geographic information and society research as presented in the Handbook. They also briefly touch on a few emerging information-age developments, in particular neogeography and volunteer geographies, both of which involve non-experts contributing and using online geographic information, motivated by their own interests and needs. The chapter closes with the identification of five cross-cutting

themes which may well be part of tomorrow's major trends in research about GIS and society.

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## APPENDIX A: LANDMARKS MEETINGS

### ***Varenius workshop: GIS and society (Harris and Weiner, 1996)*** ***[http://www.ncgia.ucsb.edu/Publications/Tech\\_Reports/96/96-7.pdf](http://www.ncgia.ucsb.edu/Publications/Tech_Reports/96/96-7.pdf)***

- Limits of representation in GIS
- Societal impacts from GIS use
- Societal influences on GIS development/use
- Critical history of GIS
- Ethics in GIS
- Privacy and GIS
- Alternative GIS or GIS2
- Use of GIS in debates about global change
- Gender and GIS

### ***Varenius workshop: public participation GIS (Schroeder, 1996)*** ***<http://www.geo.wvu.edu/i19/report/public.html>***

- Urban data sources and uses
- Dimensions of conflict and dispute resolution
- Current technological possibilities
- Future technological possibilities – GIS2
- Collaborative work
- Public process

### ***Varenius workshop: empowerment, marginalization, and PPGIS (Craig et al., 1998)*** ***<http://www.ncgia.ucsb.edu/varenius/ppgis/ncgia.html>***

- 'Successful' implementations of a public participatory GIS
- Changes in local politics and power relationships resulting from the use of GIS in spatial decision making
- What community groups need in the way of information and the role GIS plays or could play in meeting this need
- Current attempts to use GIS to 'empower' communities for spatial decision making
- The impacts on communities of differential access to hardware, software, data, and expertise in GIS production and use

- The educational, social, political, and economic reasons for lack of access and exemplary ways communities have overcome these barriers
- The implications of map-based representations of information for community groups
- The nature of GIS knowledge distortion from 'grassroots' perspectives
- The value of sophisticated analyses for understanding key issues as opposed to the negative impact of such analyses in confusing and marginalizing individuals and groups
- Implications of conflicting knowledge and multiple realities for spatial decision making
- The ways in which socially differentiated communities and their local knowledge are or might be represented within GIS
- GIS as local surveillance
- Identify which public data policies have positive influences on small neighborhood businesses and which are negative
- Develop prospective models (economic, organizational, legal, and technological) that might result in increased and more equitable opportunities among the diverse segments of society in accessing geographic information and tools
- Collaborative decision-making involving the public

### ***Varenius workshop Geographies of the Information Society (Janelle and Hodge, 1998)*** ***<http://www.ncgia.ucsb.edu/conf/InfoSoc/>***

- Institutions and GIS: emerging frameworks in the information age
- Moving beyond the map as metaphor: representation and multiple realities
- Modeling and simulating geographies in a digital world
- Access to spatial data in networked environments
- Accessibility in a wired world
- Emergent social forms
- Social/geographic implications of information technologies
- Virtual geographies

### ***Public participation GIS special issue of Cartography and GIS (Obermeyer, 1998)***

- The evolution of public participation GIS

- Empowerment, marginalization, and community integrated GIS
- GIS and community-based planning: exploring the diversity of neighborhood perspectives and needs
- Multimedia GIS for planning support and public discourse
- How and why community groups use maps and geographic information
- GPS public participation GIS – barriers to implementation
- Information technologies, advocacy, and development: resistance and backlash to industrial shrimp farming

### ***Varenius IJGIS summary and prospective article (Sheppard et al., 1999)***

- Theoretical (and methodological) perspectives on the societal implications of geographical information technologies
- The changing significance of key geographical concepts in the information age
- Societal aspects of the practical application of geographical information technologies
- Place and identity in an age of technologically regulated movement
- Measuring and representing accessibility in the information age (Information, Place, Cyberspace workshop)
- Empowerment, marginalization, and public participation GIS (PPGIS workshop)

### ***Information, Place, and Cyberspace (Janelle and Hodge, 2000)***

#### Contents:

- 1 Information, place, cyberspace, and accessibility/ Donald G. Janelle and David C. Hodge

#### ***1 Conceptualization and measurement***

- 2 Conceptualizing and measuring accessibility within physical and virtual spaces/Helen Couclelis and Arthur Getis
- 3 Evaluating intra-metropolitan accessibility in the information age: operational issues, objectives, and implementation/Lauren M. Scott

- 4 Transportation, telecommunications, and the changing geography of opportunity/Qing Shen
- 5 Space, time and sequencing: substitution at the physical/virtual interface/Pip Forer and Otto Huisman
- 6 The fuzzy logic of accessibility/Eric J. Heikkila
- 7 The E-merging geography of the information society: from accessibility to adaptability/Daniel Z. Sui

#### **2 Visualization and representation**

- 8 Representing and visualizing physical, virtual, and hybrid information spaces/Michael Batty and Harvey J. Miller
- 9 Who's up? Global interpersonal temporal accessibility/Andrew Harvey and Paul A. Macnab
- 10 The role of the real city in cyberspace: understanding regional variations in Internet accessibility/Mitchell L. Moss and Anthony M. Townsend
- 11 Accessibility to information within the Internet: how can it be measured and mapped?/Martin Dodge
- 12 Towards spatial interaction models of information flows/Shane Murnion
- 13 Application of a CAD-based accessibility model/ Paul C. Adams
- 14 Human extensibility and individual hybrid-accessibility in space-time: a multi-scale representation using GIS/Mei-Po Kwan

#### **3 Societal issues**

- 15 Accessibility and societal issues in the information age/Mark I. Wilson
- 16 Reconceptualizing accessibility/Susan Hanson
- 17 Revisiting the concept of accessibility: some comments and research questions/Sylvie Occelli
- 18 Legal access to geographic information: measuring losses or developing responses?/Harlan J. Onsrud
- 19 Qualitative GIS: to mediate, not dominate/Robert Mugerauer

#### **4 Conclusion**

- 20 From sustainable transportation to sustainable accessibility: can we avoid a new Tragedy of the commons?/Helen Couclelis

## **Community Participation and Geographic Information Systems (Craig et al., 2002)**

### *Part I Introduction*

- 1 Community participation and geographic information systems/D. Weiner, T. Harris, and W. Craig
- 2 Surveying the extent of PPGIS practice in the United States/D. Sawicki and D. Peterman
- 3 Model for making GIS available to community organizations: dimensions of difference and appropriateness/H. Leitner, R. McMaster, S. Elwood, S. McMaster, and E. Sheppard

### *Part II PPGIS case studies*

#### Inner City

- 4 A voice that could not be ignored: community GIS and gentrification battles in San Francisco/C. Parker and A. Pascual
- 5 Mapping Philadelphia's neighborhoods/L. Casey and T. Pederson
- 6 The impacts of GIS use for neighborhood revitalization in Minneapolis/S. Elwood
- 7 The Atlanta Project: reflections on PPGIS practice/D. Sawicki and P. Burke

#### Planning

- 8 web-based PPGIS in the United Kingdom/R. Kingston
- 9 GIS-enhanced land-use planning/S. Ventura, B. Neimann, Jr., T. Sutphin, and R. Chenoweth
- 10 Portland Metro's dream for public involvement/M. Bosworth, J. Donovan, P. Couey
- 11 A community-based and collaborative GIS joint venture in rural Australia/D. Walker, A. Leitch, R. De Lai, A. Cottrell, A. Johnson, D. Pullar

#### Environmental Management

- 12 Geographic Information Systems in the Environmental Movement/R. Sieber
- 13 There must be a catch: participatory GIS in a Newfoundland fishing community/P. Macnab
- 14 Environmental NGOs and community access to technology as a force for change/D. Tulloch
- 15 Mexican and Canadian case studies of community-based spatial information management for biodiversity conservation/T. Meredith, G. Yetman, G. Frias

#### Development

- 16 Promoting local community participation in forest management through a PPGIS application in Southern Ghana/P. Kyem
- 17 GIS for community forestry user groups in Nepal: putting people before the technology/G. Jordan
- 18 Implementing a community-integrated GIS: perspectives from South African fieldwork/T. Harris and D. Weiner
- 19 Information technologies, PPGIS, and advocacy: globalization of resistance to industrial shrimp framing/S. Stonich
- 20 Ensuring access to GIS for marginal societies/M. Laituri
- 21 The Cherokee Nation and tribal uses of GIS/C. Bond

### *Part III*

#### PPGIS Futures

- 22 Mutualism in strengthening GIS technologies and democratic principles: perspectives from a GIS software vendor/J. Dangermond
- 23 Spatial multimedia representations to support community participation/M. Shiffer
- 24 GIS and the Artist: shaping the image of a neighborhood through participatory environmental design/K. Al-Kodmany
- 25 A praxis of public participation GIS and visualization/J. Krygier
- 26 A model for evaluating public participation GIS/M. Barndt
- 27 Public participation, technological discourses and the scale of GIS/S. Aitken
- 28 Conclusion/W. Craig, T. Harris, D. Weiner

#### Major themes in *Community Participation and GIS*

- GIS as tool of reason
- GIS as communicative tool
- GIS as tool for community resistance
- CPGIS as 'pioneering'
- CPGIS not a panacea
- GIS to support 'community participation'
- What is 'community' and 'public participation'?
- Consensus
- Local knowledge
- Empowerment and marginalization
- Political

Access to geographic information and participatory processes special issue of the *Urban-Regional Information Systems Association Journal* (URISA, 2003)

Part I – Workshop on access to geographic information and participatory approaches in using geographic information

- Toward a framework for research on geographic information-supported participatory decision-making
- In search of rigorous models for policy-oriented research: a behavioral approach to spatial data sharing
- Cultural and institutional conditions for using geographic information; access and participation
- A new era of accessibility?
- World status of national spatial data clearing-houses
- Access to geographic information: a European perspective
- The future of participatory approaches using geographic information: developing a research agenda for the twenty-first century
- Transparency considerations for PPGIS research and development

Part II – Workshop on access to geographic information and participatory approaches in using geographic information

- Public participation GIS and local political context: propositions and research
- Directions
- The issue of access: an assessment guide for evaluating public participation
- Geographic information science case studies
- Reflections on PPGIS: A view from the trenches
- Geographic information and public participation: research proposal from a French perspective
- Digital participation and access to geographic information: a case study of local government in the United Kingdom
- The intersection of data access and public participation: impacting GIS users' success?
- Community-integrated GIS for land reform in South Africa
- A framework for the use of geographic information in participatory community planning and development

### ***Special issue on GIS and Social Science in Cartographica (Schoorman and Kwan, 2004)***

#### ***SPECIAL ISSUE: GIS AND SOCIAL SCIENCE: NEW RULES OF ENGAGEMENT***

- Taking a walk on the social side of GIS
- The utopian potential of GIS
- The third domain: the spread and use of GIS within social science
- Rewiring for a GIS
- GIS and geographic governance: reconstruction the choropleth map
- Adapting to the Machine: Integrating GIS into Qualitative Research

### ***UCGIS Research Agenda – chapter on GIS and society (McMaster and Usery, 2005)***

#### ***GIS and society***

- COLO-4 Study ethics of access, copyright, personal liability, and protection of intellectual property for spatial data and related products publishes, delivered or distributed electronically.
- MN-1 Institutional barriers to use of GIS in decision making
- OH-5 The social impacts of spatial information technologies
- WISC-5 The social impacts of spatial information technologies
- SDSU-4 Developing a critical social theory of GIS
- WVU-1 Representing multiple realities, new models of space

#### ***GIS in decision making***

- CLRK-5 GIS and decision-making technique
- MN-1 Institutional barriers to use of GIS in decision making
- ORNL-5 Linkages between GIS research and business/government decision making
- WY-1 Decision support systems integrating spatial data with models, expert knowledge and graphical user interfaces are needed for effective and efficient management of natural resources

### *Participatory GIS*

- CLRK-3 Linking participatory approaches in institutional environments
- ME-4 Public forum GIS

### ***Spatially Integrated Social Science (Goodchild and Janelle, 2004)***

- Thinking spatially in the social sciences/Michael F. Goodchild and Donald G. Janelle
- Inferring the behavior of households from remotely sensed changes in land cover: current methods and future directions/Bruce Boucek and Emilio F. Moran
- Geovisualization of human activity patterns using 3D GIS: a time-geographic approach/Mei-Po Kwan and Jiyeong Lee
- Agent-based modeling: from individual residential choice to urban residential dynamics/Itzhak Benenson
- Too much of the wrong kind of data: implications for the practice of micro-scale spatial modeling/David O'Sullivan

### *Neighborhood-level analysis*

- Identifying ethnic neighborhoods with census data: group concentration and spatial clustering/John R. Logan and Wenquan Zhang
- Spatial analyses of homicide with areal data/Steven F. Messner and Luc Anselin
- Spatial (dis)advantage and homicide in Chicago neighborhoods/Robert J. Sampson and Jeffrey D. Morenoff
- Measuring spatial diffusion of shots fired activity across city neighborhoods/Jacqueline Cohen and George Tita
- The spatial structure of urban political discussion networks/Munroe Eagles, Paul Bélanger, and Hugh W. Calkins

### *Region-level analysis*

- Mapping social exclusion and inclusion in developing countries: spatial patterns of São Paulo in the 1990s/Gilberto Camara, Aldaiza Sposati, Dirce Koga, Antonio Miguel Monteiro, Frederico Roman Ramos, Eduardo Camargo, and Suzana Druck Fuks

- Business location and spatial externalities: tying concepts to measures/Stuart H. Sweeney and Edward J. Feser
- Updating spatial perspectives and analytical frameworks in urban research/Qing Shen
- Spatial analysis of regional income inequality/Sergio J. Rey
- Shaping policy decisions with spatial analysis/Ted K. Bradshaw and Brian Muller
- Geographical approaches for reconstructing past human behavior from prehistoric roadways/John Kantner

### *Multi-scale spatial perspectives*

- Time, space, and archaeological landscapes: establishing connections in the first millennium BC/Patrick Daly and Gary Lock
- Spatial perspectives in public health/Anthony C. Gatrell and Janette E. Rigby
- The role of spatial analysis in demographic research/John R. Weeks
- Spatial interaction models of international telecommunication flows/Jean-Michel Guldmann
- Planning scenario visualization and assessment: a cellular automata based integrated spatial decision support system/Roger White, Bas Straatman, and Guy Engelen

### ***URISA 2005 PPGIS Conference topics (URISA, 2005) <http://www.urisa.org/PPGIS/ppgis.htm>***

#### *Critical GIS*

- Gender, race, class diversity of information use
- Types of power influencing information creation and use
- Access to information and implications for outcomes
- Subjectivity/positionality of information producers and users
- Correspondence of world, database, map database representation as validity
- Types of democracy and implications for public involvement
- Social/environmental justice
- Critical perspectives on cartography

### *Practice, monitoring and evaluation of GIS use*

- Case studies illustrating a successful implementation of GIS
- Participatory use of GIS by stakeholder groups
- Use of GIS in specific sectors (e.g. social service provision and policy, health services, urban planning, environment, transit and disability)
- Developments of applications to analyze and model data, collect and display information, inform and educate the public and advocate for policy change.
- Techniques (cartographic designs, visualization methods, computational and analytical methods) (probably belongs in GIScience below)
- Integration of GIS and other technologies (e.g., Internet, GPS and simulation software)
- Educational, social, political and economic barriers to access and exemplary ways communities have overcome these barriers
- Techniques and measures for the evaluation of GIS

### *GIScience*

- Ontology and scale in GIS for social science applications
- Implications of map-based representations of information for community groups
- The nature of GIS knowledge (e.g., local versus expert knowledge, transforming data into knowledge)
- Politics and power relationships resulting from the use of GIS for decision making
- Ethical issues in GIS
- GIS as used for surveillance and corporate control
- Models of economic, organizational, legal and/ or technological issues that increase and equalize access to GIS tools for diverse segments of society

- Data models that reflect the sanctity and values of local cultures
- Impacts on communities of differential access to hardware, software, data and expertise in GIS production and use
- Role of GIS in meeting the information needs of community groups
- Role of spatial analyses in understanding/marginalizing communities
- Virtual communities and physical communities in PPGIS
- Quality control for research
- Modeling participatory processes

### *Data issues*

- Encryption, confidentiality, and privacy of spatial data
- Legal issues and information ownership
- Data sources, quality and accuracy
- Public information dissemination, sharing and access
- Data models that reflect values of the local culture
- Libraries as spatial data (including metadata) providers and educators

### *Organizations and institutions*

- Role of public and private sectors in social use of GIS
- Education and learning structures for social use of GIS
- Funding structures and sources
- Sustaining PPGIS – securing funding after seed grants end, training and retaining staff, data maintenance and so on
- Emergence of technical assistance/data provision infrastructure
- Economics of GIScience/systems

