Preface

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It is now almost forty years since Roger Tomlinson coined the term *geographic information system* (GIS), and led the development of the world's first, the Canada Geographic Information System (CGIS), in the mid 1960s (for a history of GIS see Foresman, 1998). Today's technology would be almost unrecognizable to the pioneers of the 1960s, not only because of the almost unbelievable advances in information technology that have occurred since then, but also because of dramatic changes in the functionality, appearance, use, and societal context of GIS. This book addresses one of the most recent manifestations of those changes, the developing use of GIS by grass-roots community organizations, and participation in its use by ordinary citizens.

Early GIS was massively expensive. CGIS required a large, dedicated mainframe computer costing several millions of 1965 dollars; the development of hundreds of thousands of lines of computer code in very primitive programming language; and the invention of novel devices for converting maps to digital form. Although the project was based on sound cost-benefit analysis, the technical problems of building CGIS were such that by the early 1970s, and despite the expenditure of tens of millions of dollars, CGIS was essentially unable to deliver the results that had been promised to its sponsors, and several more years of effort were required to bring it to operational status.

CGIS was a child of its time. Only senior governments were able to afford the cost of early GIS, and only skilled experts were able to do successful battle with its primitive interfaces. As with other early computer applications, early GIS was designed to augment the limited and fallible skills of humans, by performing tasks that humans found too difficult, tedious, or inaccurate when done by hand; in the case of CGIS, these tasks included measuring areas from maps, and overlaying maps, both on a massive scale. In essence, CGIS was performing the geographic equivalent of other applications driving early computer development -- the massive numerical simulations of nuclear explosions being performed by Los Alamos National Laboratory, or the massive cryptographic computations of the National Security Agency.

Early computers quickly gained a popular image of mechanical efficiency, lightning speed, and perfect accuracy that was in sharp contrast to supposed human characteristics of clumsiness, sluggishness, and vagueness. As such, both they and GIS fed the human appetite for enlightenment. Computerized maps would replace the stained, creased, and tattered maps of the glove compartment. Instead of inaccurate maps recording someone's impression of land use at some undetermined point in the past, the civilian remote sensing satellites that began to appear in the early 1970s would continuously monitor the Earth's surface and ensure a constant, up-to-date, and precise digital record.

Early GIS was also firmly grounded in science, and its associated ideas of objectivity and replicability. We knew, of course, that some of the data being entered into CGIS had been invented by poorly paid undergraduates idling in coffee shops, but once in the computer and stripped of this awkward human lineage the data appeared to all intents and purposes as if they had been measured by the most precise of scientific instruments. The scientific measurement model dominated early thinking in GIS, and may have reached its apogee in the Digital Earth speech of Vice President Al Gore in 1998, describing a future in which it would be possible to enter and explore a virtual world based on a perfect digital replica of the planet that included measurements of practically everything.

Early GIS was not surprisingly much more attractive to users whose applications lay in the physical and natural sciences, than in the social sciences. Although GIS made useful inroads into marketing and site selection (Martin, 1996), by and large it was the physical aspects of the planet that dominated early GIS use. GIS was adopted by forest management agencies and lumber companies; by engineering consultants and utility companies; by Earth system scientists, landscape ecologists, and agronomists. But only recently has there been substantial interest among sociologists, economists, and political scientists in the potential of GIS to elucidate social processes (for more on the social science applications of GIS see CSISS.org).

Many factors have contributed to the evolution of GIS over the past forty years, and brought it to the state in which we find it today. First and perhaps foremost is the cost of hardware. The power of the multimillion-dollar computer used by CGIS is now vastly exceeded by the average laptop, and the most advanced GIS applications now run on computers costing less than $2,000. At this level GIS is affordable by many libraries, schools, households, and community organizations, although it is still far beyond the reach of others, particularly in developing countries. The cost of software has also dropped substantially, in tandem with the cost of hardware, as demand for both has grown.

Second, developers of GIS software have made great progress in facilitating use, through improved user interfaces. Early GIS required its users to learn its specialized language, and by the late 1980s command languages had grown to include thousands of terms, to be used in precise and unforgiving syntax. But the early 1990s brought WIMP (windows, icons, menus, pointers) interfaces into the computing mainstream. Learning to use GIS is still a challenge, but it is now at least possible for children in elementary school to use it effectively. We are still a long way from the kind of intuitive interface that would be readily usable by a child of ten, but GIS users no longer require skills comparable in complexity and sophistication to those of concert pianists.

This trend towards more intuitive interfaces is part of a deeper, third trend, towards a more human-centric vision of GIS. Researchers in the early 1990s noted how GIS interfaces were essentially *intrusive*, requiring their users to learn the system's language, rather than adopting the intuitive language of humans. We humans work every day with geographic information, as we share driving directions, describe distant places to each other, or reason about the information we acquire through our senses. Much is known about how children acquire spatial skills, and how they build mental models of their surroundings. If the conceptual structures of GIS were similar, it was argued, then GIS would be necessarily easier to use, and accessible to a much larger proportion of the general public, including children. GIS researchers began to discover cognitive science, and those parts of linguistics that deal with concepts about the geographic world (Frank and Mark, 1991).

Human discourse is inherently vague, and science has long been concerned with providing an alternative to vague subjectivity. Instead of describing things as hot or cold, scientists measure temperature on standard scales in order to ensure replicability and shared meaning, and early GIS similarly imposed requirements of precision on its users, forcing them to replace vague terms like *near* with precise measurements of distance. So while on the one hand this ensured objectivity and meaningfulness, it also acted as a filter. Human discourse is vague, but it is at the same time semantically rich, with nuances that allow one word to have many context-specific shades of meaning. By comparison, the scientific GIS is precise, but also crude in its simplicity.

The final twist in this transition was brought about by the information technology revolution of the 1990s, which not only put computers into the hands of millions, but demanded that they address everyday needs. No longer would users be required to learn the language of computers – the new software interfaces of the 1990s were designed to do something useful for the average person almost immediately upon installation. The spreadsheet software of the 1980s probably did the most to precipitate this trend, but by the late 1990s even GIS was starting to enter the application mainstream. Computers were now seen not as calculating wizards but as connections to the Internet, providing essential channels of communication between humans (Goodchild, 2000). By extension, a GIS was no longer a way of doing things that humans found tedious, time-consuming, or clumsy to do by hand, but the means by which humans exchanged information about the world around them. A GIS ought to be able to accommodate all ways of describing the world, from maps and images to stories, pictures, and sketches. When such descriptions are sufficiently precise, it should be possible to reason and analyze them automatically by selecting from a battery of standard techniques; but precision should not be a requirement for entry into the GIS world.

Any community attempts to maximize its wellbeing and potential within the constraints imposed on it by its technology and its environment. Communication and sharing of geographic information are essential to the successful functioning of communities, because they are the means by which each individual extends his or her knowledge beyond the limits of the human senses – we learn what is beyond the mountains, or across the river, or what used to be in the past, by communicating with others who live there or have been there, or by sharing the products of satellites that can see from space. New technologies are adopted if they loosen the constraints of older ones, allowing the community to reach new levels of wellbeing. In that sense the information technology revolution of the late 20th Century has greatly loosened the constraints on human communication, by providing new channels that are capable of transmitting virtually any form of information at high speed and minimal cost.

This book is about some of the potential that new information technology offers to communities. It could not have been written in the 1960s, and perhaps not as recently as ten years ago, so it is very timely. If GIS is indeed ubiquitous and easy to use – and there are many reasons why we have not yet reached that point – then it has the potential to revolutionize the ways in which communities develop consensus about their surroundings, resolve disagreements and difficulties, and plan for the future. But there are few guidelines on how to take advantage of the undoubted power of modern GIS, and community participation will clearly occur in settings that are very different from those faced by the GIS pioneers and the users of early GIS: indeed, in many cases communities will find themselves using GIS to oppose and disarm the agencies that adopted GIS much earlier, under the older paradigm. An early instance of this occurred in the 1980s on the North Slope of Alaska, when the local burrough government found itself with no alternative but to adopt the then-expensive technology already being used by the oil companies in Prudhoe Bay to build arguments in support of land use permits, and paid for it with oilfield royalties.

This book is a collection of reports from pioneers who are developing the guidebooks, and creating the roadmaps. They are experimenting with new forms of visualization that are more readily understood by non-experts; with new forms of representation that recognize multiple perspectives on the same reality; and with new forms of community interaction through the Internet and its communication technologies. Many of these experiments will ultimately enrich GIS technology, by driving a new generation of technological developments. But the ultimate test will occur some time in the future, when it will be possible to ask the fundamental question: how does GIS affect the ways in which communities are able to build awareness of their surroundings, develop consensus, and argue persuasively for a better future?

As Chair of the Executive Committee of the National Center for Geographic Information and Analysis, I am honored to have been asked to write this preface to this book, which stems in part from an NCGIA-sponsored workshop on public-participation GIS (PPGIS), funded under the Varenius project, NCGIA's effort to advance geographic information science. The National Science Foundation provided funding for the workshop and the Varenius project under Cooperative Agreement SBR 9600465. The leaders of the workshop and the editors of this book are to be congratulated on stimulating a new level of interest in the use of GIS in community development and planning, and I hope this book will make the work in this area accessible to a larger audience, including practitioners as well as researchers in the many disciplines that overlap PPGIS.

References

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