FOREWORD

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In the decade and a half since the release of the first popular Web browser (Mosaic, released by the National Center for Supercomputer Applications in 1993), the Internet and electronic communication have had profound and still accelerating impacts on society, at least on the well-resourced side of the digital divide. It is salutory today to read some of the literature of the early 1990s, and to note its almost complete failure to anticipate these impacts. In the introduction to the second edition of *Geographical Information Systems*, published in 1999, my coauthors and I noted our lack of a single reference to the Internet in the two volumes, 56 chapters, and almost 1100 pages of the first edition (Maguire, Goodchild, and Rhind, 1991).

The first Web maps appeared within months of the release, allowing users armed with nothing more than a copy of Mosaic to display and interact with a map instantaneously by contacting the Xerox Palo Alto Research Center's server. The use of the Internet to provide easy access to geographic information (GI) grew rapidly, as exemplified by early repository projects such as the Alexandria Digital Library (www.alexandria.ucsb.edu) and later by a flood of more sophisticated geoportals (e.g., the Geospatial One-Stop, www.geodata.gov). Whereas early teaching in geographic information systems (GIS) had required students to go through the gruelling and mind-numbing exercise of hand digitizing, today that content has been almost entirely dropped from the curriculum, and students are now trained in how to find their data on the Web.

But like the "horseless carriage" of the early 20th century, this world of Web-based GI search and retrieval merely improved on previous arrangements, preserving almost all of their institutions and metaphors. By the turn of the century one could be forgiven for thinking that the Internet and Web had simply allowed us to do the same things better, sometimes more cheaply and quickly, but almost always with less skill and effort. The institutions that had evolved over decades remained in place, while the new technology placed more emphasis on the need to share GI among them, a recurring theme in the chapters of this book.

A far more fundamental change began to impact the world of GI in the appearance of wayfinding sites, initially popularized by MapQuest and later followed by a host of imitators. While these sites also provided access to GI, they functioned not as libraries ready to distribute data, but as services that processed their data to address queries posed by users. The functions of address matching (finding the geographic coordinates of a street address) and optimum routing (finding the best route from an origin to a destination) had long been available to professionals trained in the complex user interface of a GIS, but MapQuest made them available to all, and via a remote and well-maintained server rather than from the user's own desktop or laptop machine. More and more such

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granular GIS services became available online, providing cheaper, more reliable, and more accurate answers than most users could afford to provide for themselves. Eventually the approach became known as *service-oriented architecture*, and the use of such services as *cloud computing*. It also led to a profound organizational change, as users came to rely on companies for basic GI services, instead of the traditional combination of downloaded government data and local processing—and companies in turn found business models, often based on advertising, that could provide the necessary income stream.

One of the great triumphs of the Web has been its ability to provide easy access to a host of sources using very simple standards and specifications. HTML and a small number of graphics standards provided the initial impetus, replacing a Babel if not by a universal language or Esperanto (Chapter 2), then at least by selected specifications and plug-ins. In the GI world online services now make the task of conversion between alternative methods of georeferencing (latitude/longitude, street address, placename, coordinate systems, etc.) trivial, so that information from multiple sources can be combined using location as a common key. The result has been a rapid proliferation of *mashups*, Web services that combine two or more sources to present information that would not have been available from either. For example, the Fundrace service (fundrace.huffingtonpost.com) makes it possible to create a local map of donors to political campaigns, by combining information from the national database of donors with a mapping service. By allowing Web developers to invoke its services from within their own, Google has established Google Maps as the basis for thousands of such mashups.

Another change of profound significance to GI occurred in 2005, driven in large part by the increasing sophistication of the graphics capabilities of standard computing hardware, which were driven in turn by the lucrative video-game market. Whereas it cost several hundred thousand dollars in the early 1990s to acquire a computer capable of dynamic three-dimensional display, by 2005 the average $1,000 desktop could perform almost as well. In that year Google released its Google Earth client, and for the first time the average user was able to display and manipulate the globe as a spherical entity. The centuries of earth-flattening distortion that had been driven first by the necessity of paper communication, and later by the limited visualization capabilities of early computers, were suddenly over. Once more the effect was to reinforce corporations, and lessen the influence of the traditional public-sector GI institutions.

But the most profound organizational transformation was yet to come. By the late 1990s it had become commonplace for Web sites to solicit input from users, in the form of reviews (e.g., amazon.com) or advertisements (e.g., Craigslist), and to make this information available to others. Within a few years this type of practice had mushroomed to the *social media* we see today, the world of blogs, wikis, and other forms of user-generated content (UGC) that are often termed *Web 2.0* to distinguish them from the earlier domination of the Web by authoritative, top-down information flow. It was inevitable that this trend would impact the world of GI, because many forms of geographic information are intuitive, needing no particular expertise to collect, and because citizens are far more densely distributed over the earth's surface than the experts

who had previously dominated the production of GI. Satellite-based remote sensing and aerial photography are massively efficient techniques for GI acquisition, but there are many characteristics of places that such systems cannot "see".Who better than the average citizen to contribute, correct, or update such *volunteered geographic information* (VGI; Goodchild, 2007)? The term *neogeographer* (Turner, 2006) has been coined to describe citizens in this role, since they perform many of the traditional mapping functions of the expert geographer. Recently I have argued that the role of the neogeographer may not be limited to the more simplistic types of GI such as placenames and streets (Goodchild, 2009), but may complement or even replace traditional methods for creating all types or themes of GI.

Traditional GI institutions are often national (e.g., the national mapping agencies), oriented to authoritative production of data at multiple scales, and covering multiple themes. This new world of VGI is often focused on a single theme, and often local in its geographic coverage. For example, the 2007–2009 series of wildfires in Santa Barbara County stimulated the creation of several local Web-based services dedicated to rapid dissemination of GI during emergencies. Although this GI is generally not authoritative, it is often valued more by impacted citizens because it appears more rapidly than official data. Sites can be found dedicated to personal narratives about locations in Toronto (MurmurToronto.ca), variation over the US of the terms used to refer to carbonated beverages (popvssoda.com), or the creation of a volunteered global streetmap (OpenStreetMap.org). The institutions that sponsor or emerge in support of such efforts are themselves local, regional, or global, and general or thematically based, depending on the context.

In many cases there is no existing institution that can fit the need created by such services. In Nova Scotia's rural Annapolis Valley, for example, the community like many others is actively engaged in numerous projects to create VGI, ranging from the mapping and transcription of gravestones to the recording of community genealogy. While such activities can flourish without any institutional framework, the need for continuity of the project and long-term preservation of its products will inevitably force one to be identified or created. Local governments typically lack the resources, regional governments are organized at too coarse a geographic scale, and while national governments may provide initial funding, that is unlikely to be sustainable in the long term.

In short, the profound changes that neogeography, VGI, and Web 2.0 have wrought in the past few years, and the broader implications of social media, suggest a fundamental reorganization of society, a re-institutionalization, in which the older authoritative institutions either fade into irrelevance, or learn to collaborate with an empowered citizenry. This is the backdrop against which this book is being published, and it suggests that in ten, perhaps as little as five years the landscape of GI organizations that we currently see will have altered in dramatic ways.

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