FORUM

Geospatial Technologies and the Geographies of Hope and Fear

Brian Klinkenberg

Department of Geography, University of British Columbia, Vancouver

The geographies of hope and fear are a rich vein of investigation in our discipline. Social theorists have discussed how geospatial technologies (GSTs) are things to be feared. They point to the loss of privacy, to the use of technologies in warfare, and to the growth of surveillance. I explore this understanding and the "evil" side of geospatial technologies, and I present the alternative view—a view of these technologies as harbingers of hope. GSTs have a positive role to play in environmental protection, in health, and in social justice. There is a need for the involvement of more human geographers in technological development in order to allow for critical analyses of the social impacts generated by these technologies. Only by shining the spotlight of critical geographical analyses on development of GSTs, and their uses, can we ensure that technological development is kept on a path of positive development. This addition of the social to the technological is imperative and requires an active role on the part of geographers. Geographers, and geography as a discipline, are well suited to this challenge, and as islands of researchers coalesce into a synergistic "mainland community" of cooperative investigation into GSTs the result will be a well-woven fabric of socially responsible technology. *Key Words: geospatial technologies, GIS, hope and fear, surveillance.*

Geography is an eclectic discipline, covering both the social and the physical, and placing both in the landscape. A frequent thread of investigation in geography is the exploration of society: what makes it tick and what informs it. In particular, geographers have often explored societal issues that generate fear. In recent years, there has been considerable exploration of the effects of war and conflict (Hyndman 2000), famine and food supplies (Herdt 2004), social alienation and its links to crime (Bowers and Hirschfield 1999), the politics of water (Bakker 2003), private armies (Le Billon 2001), globalization (Dicken 1994), Big Brother, and even geographical information system/geospatial technologies (GIS/GSTs) as part of a military- and espionage-based world (Monmonier 2002). The vein of deconstruction in these areas has been rich and has shed light on many areas of society, not the least of which is the very obvious vulnerability of women, both in war-torn societies and in the so-called stable democratic societies where women fear to walk the streets alone at night.

There is no doubt that GSTs have engendered fear as the reality of Big Brother and Orwell's *1984* looms above us. Geospatial technologies appear entrenched in surveillance, warfare, and invasion of privacy, and human geographers have been quick to address these roles. They point to an Orwellian future that appears to be running amok, where smart cards invade our privacy and satellite surveillance becomes public fare. GSTs represent a tidal wave of change in our societal structure, and appear to be leading us toward the brink of a "brave new world."

But if you ask many GST researchers, they are surprised to learn that geospatial technology engenders fear. They see only the positive aspects of the technological era. They highlight the ways in which GSTs shine a spotlight into dark corners of data (mis)interpretation, the way they expose inadequacies of knowledge, the way they can harness the power of the computer for the greater good in the environment, in emergency planning, in health geography, and in issues of social justice. They see GSTs as empowering the public.

This dichotomous view of GSTs, the good and evil that is ever present within its framework, is interesting and worthy of exploration in itself. In this article, I examine the dichotomy of hope and fear and attempt to place GSTs within a framework of their being, one that can seem fearful, but one that can also produce hope. I also discuss how geographical inquiry into the realm of GSTs, such as GIS, is necessary and beneficial, and how that inquiry itself represents hope—a way of diluting the fear that surrounds technology. By becoming integral to the

Annals of the Association of American Geographers, 97(2), 2007, pp. 350–360 © 2007 by Association of American Geographers
Initial submission, August 2005; revised submission, May 2006; final acceptance, December 2006
Published by Blackwell Publishing, 350 Main Street, Malden, MA 02148, and 9600 Garsington Road, Oxford OX4 2DQ, U.K.

technology, geographical inquiry and social awareness are the hope of the future, through which we may truly enter a brave new world, one that is democratic, governed by ethics, and represents the world we would like to see—a world based on equalization of the power base. Technology breeds power, but technology can also control power.

Geographers are well placed to interrogate and react to the technological era, to explore the changing geographies of fear and hope. Our tradition has long been to consider the global through the lens of the local. There is considerable convergence occurring within the discipline, with social theorists, feminist geographers, urban geographers, spatial analysts, and others now working together in shaping the future of geospatial technologies within and outside of the discipline (e.g., Clark 1998; Harvey and Chrisman 1998; Openshaw 1998; Philip 1998; Sui 1998, 2004b; Hoeschele 2000; Sieber 2000; Kwan 2002a, 2002b; Richardson and Solis 2004). If we recognize that fear—although expressed on an individual level—is principally a social phenomenon (Seppälä 1999), then it is clear that collectively we must act to ensure that technology and hope become synonymous.

Defining the Evil One: What Is Good, What Is Evil?

I do not fear computers. I fear the lack of them.

—Isaac Asimov

What are geospatial technologies? The U.S. Department of Labor defines the geospatial industry as "an information technology field of practice that acquires, manages, interprets, integrates, displays, analyzes, or otherwise uses data focusing on the geographic, temporal, and spatial context" (DoL 2004). From this definition we can infer that geographic information systems, Global Positioning Systems (GPS), photogrammetry, remote sensing, cartography, surveying, and other related fields are all considered part of geospatial technologies. Furthermore, devices such as cellular phones, PDAs (personal digital assistants), and RFIDs (radio frequency identification tags—seen by some as possibly the final blow to privacy; Mediamatic 2005) are increasingly becoming integral components of geospatial technologies because of the locational information that is embedded in them or is enabled by them. Video surveillance cameras should also be included as a geospatial technology because feature recognition software increasingly enables video systems to track people through space and time (Gray 2003; Dodge and Kitchin 2005).

How do geospatial technologies and products produce fear or hope? The first premise that should be considered is whether GSTs themselves are good (bringers of hope) or evil (harbingers of fear). Such issues of good and evil would not have come so forcefully to the fore had it not been for the tragic events of 11 September 2001 (hereinafter "9/11"), or the Gulf War before that, and the resultant sea change in public perception of hope and fear in our society.

It is important first to identify that most technologies (and information) are not themselves good or evil, as Nigel Waters (2004), Dobson and Fisher (2003), Richardson and Solis (2004), and many others have stated. It is in the use of technology that either good can result, or fear (but see Feenberg 1991). It would be foolish, however, to assume that because we do not see our work as engendering fear, that fear could not result. Ultimately fear can result from both the technology itself and from unequal access to information (Clark 1998).

Fear can also result from intentional or unintentional deception, misrepresentation of fact, or lack of understanding. Maps, for example, are capable of producing considerable deception (e.g., Herb 1999) and of generating fear, even if the intent was to allay concerns and provide hope (Monmonier 1996; Gersmehl 1997). We must fully and carefully consider the Janus-like qualities of maps and, more broadly, of GSTs if we are to harness the power of these technologies in a positive way. We must ensure that we do not contribute to the climate of fear by generating poor maps. We live in a world where many real threats exist, and by careful analyses and appropriate use of geospatial technologies we can help identify those threats that are real.

In the past there have been extremely divergent attitudes toward GSTs and how that technology is embraced and used within institutions (e.g., Pickles 1991, 1995; Smith 1992; Gregory 1994; Flowerdew 1998; Openshaw 1998). In particular, the criticisms about GIS in the 1990s were often made by outsiders, by people not actually engaged with the practices of GIS. Today, however, we are seeing a more involved approach (e.g., Kwan's 2002b feminist examination of the technology) to critical studies of, and studies using, GIS and other spatial technologies that enable an opening up of the previously perceived "single official reading" (Hoeschele 2000, 296) that was associated with GIS in the 1990s (Schuurman 2000; Kwan 2002a; Monmonier 2002). Notions that the Cartesian space-time grid of GIS forces a grid epistemology on its users (Dixon and Jones 1998), that it is inherently a masculinist technology, that use of spatial technologies leads groups to adapt to the demands of the technology (Hoeschele 2000) enforcing a hegemonic technical standard are increasingly being questioned by informed researchers (e.g., Clark 1998;

Harvey and Chrisman 1998; Sui 1998; Sieber 2000; Kwan 2002b). Philip (1998, 263) notes that "epistemology should inform, rather than dictate, methodological choices," and Clark (1998) and Sieber (2000) have noted nongovernmental groups increasingly bending GST to meet their needs.

Outside of the academic geography community, the feelings expressed by most people directly involved with geospatial technologies are almost universally highly positive. The e-mail presented below, received in response to my request to a geospatial technologies list server for stories of hope and fear, summarizes the tenor of the responses that were sent:

> Your request caught my eye for the very reason I had never in my entire forty-five year career thought of the application of geospatial technologies in the context of fear. It has always from my perspective been applied because of hope, although I must concede that fear of losing something is a motivator as well. . . . The message to me has always been hope.
>
> —(e-mail from Jule A. Caylor, USDA Forest Service, Remote Sensing Applications Center, March 2005)

In spite of (or, maybe, in light of) these responses, however, there is an obvious need for geographers to move the debate about issues surrounding the use and abuse of GSTs into the wider realm of commercial, governmental, and nongovernmental users, and to hold discussions with those actually performing the analyses or determining the policies on issues such as privacy and surveillance and on the gendered nature of the technology. Whether we have been/can be successful in pursuing such an agenda is nonetheless open to debate (see, e.g., Martin 2001, 2002; Dorling and Shaw 2002; Sui 2004a).

Examples of positive aspects of geospatial technologies are myriad and include their use in conservation, emergency planning, community mapping, landmine clearing, hazards management, public health, and crime mapping. Geospatial technologies allow for the transfer of knowledge from the hands of the few to the hands of the many; these technologies inherently bring with them a shift in the balance of power. Governments may try to prevent this transfer for various reasons, but the information era works both ways and the power of GIS and spatial technologies such as remote sensing and GPS allows groups to deconstruct arguments by exposing inconsistencies, errors, and omissions in any analyses (Sieber 2000). Books such as *Mapping Hacks* (Erle, Gibson, and Walsh 2005) illustrate just how mainstream mapping has become. Projects such as "The Neighborhood Project" (Chisholm and Cohen 2005; see also Elwood 2006), for example, show how local groups can use corporate resources (i.e., Google Maps) for collaborative, local community-based mapping. As Goodchild (2000) and Rushkoff (2005) note, the professional cartographer has in some ways been marginalized since everyone can now make a map. Despite this democratization of mapmaking, however, the need to ensure effective and correct cartographic communication—an informed display of information and information interpretation—means that a strong role remains for cartographers. They are the public educators on the uses and abuses inherent in maps and spatial analysis.

Conservation is one area where geospatial technologies work in many positive ways through dissemination of knowledge (e.g., Sieber 2000). An example of the benefit that geospatial technologies, and in particular interactive maps, can bring to conservation—in the spirit that Jule Caylor is invoking—is E-Flora BC, a cooperative, public-based project that aims at providing comprehensive scientific information on all plant species found in British Columbia (Klinkenberg 2006). By placing detailed distribution maps, images, taxonomic, and ecological information on the Internet, the group hopes to prevent species loss by highlighting rarities and, critically, identifying or spotlighting knowledge gaps. Bureaucrats cannot declare ignorance if the information about imperiled species is freely and easily available within the public domain.

There are in fact thousands of projects like this one on the Internet. It is through the democratization of information (e.g., Obermeyer 1995; Clark 1998; Klinkenberg 2003) that new geographies of hope are generated. Freely available information provided through formal portals such as government Internet mapping services, or produced by "hacking" into sites such as Google Maps (Erle, Gibson, and Walsh 2005) or by the myriad GPS users around the world, can also lead to new social constructions and can ultimately strengthen communities through both knowledge acquisition and increased civic participation. What geospatial technologies can do is subvert ignorance and misinformation, willful or otherwise, enabling a shift from an elite power base to a broad democratic (open source) base.

Many people still express strong, not necessarily positive, feelings about geospatial technologies and GIS (e.g., Katz 2001, 1215). Christopher Bruce, a crime analyst in the Cambridge, Massachusetts, police department, feels that maps mask issues of (poor) data quality and (a lack of) interpretation, that map production has come to supersede analysis per sé (Bruce 2001). He rightfully and strongly advocates that no map be presented without detailed analysis (interpretation and explanation) accompanying it. He worries that the "wizardry" of GIS will

hamper the real work of crime analysis: searching for answers to the who, what, when, how, and why questions should be the driving force, not the production of maps that only answer where (Bruce 2001).

Obermeyer (1995) presents an alternative set of concerns about the rise of a hidden GIS technocracy. She notes that most organizations are unaware of, and are possibly even unable to formulate appropriate questions about, the nature of the spatial models embedded within GIS software. As the use of GIS progresses from a simple data storage and mapping technology (by far the most dominant use by most governmental organizations today) to more sophisticated spatial analyses, problems associated with the use of inappropriate methodologies arise. Her concerns echo those of others who feel that the complexity of GIS and spatial analysis technologies undermines their use as an opposition technology (Clark 1998). Proper spatial analyses—ones that consider the spatial contingencies (e.g., the modifiable areal unit problem, map projections)—are not simple and do require advanced knowledge. As such, because use and misinterpretation by nonexperts is inevitable, and misuse by academic researchers who use software without realizing the implications of the embedded choices on their research continues to occur, those criticisms and concerns can never be completely overcome no matter how "intuitive" the user interface to a GIS becomes.

Ethics, GIS, and Expertise

Improperly or inappropriately produced maps, however, represent only the tip of the iceberg of issues involving geospatial analysis. Even the most cartographically-correct and thoughtfully-produced map is not without its issues (e.g., Monmonier 1996); it is more than beauty that is in the eye of the beholder. There is the question of ethics in "translating" information. Should the transformative, authoritative nature of maps and GIS necessitate that all analysts subscribe to a public code of ethics, such as that presented by the GIS Certification Institute (GISCI 2006)? This may be part of the solution. However, no matter how well considered a code of ethics may be, it cannot address issues such as the geospatial intelligence of the analyst nor, and possibly more important, the ability of the end user to judge the appropriateness of the map (or other geospatial product) and of the spatial analysis that lies behind it. Geographers obviously have a role to play here—educating the public (both the producers and the consumers of the maps) about the complexities involved in working with spatial data and querying the software developers about the spatial models they embed within their programs.

This point of course leads to a necessary discussion of how well do geographers educate? In spite of the growing use of GIS and geospatial analyses across a wide variety of subject areas, there remains the problem of expertise. Geospatial information presentation and analysis is a specialized field requiring understanding of statistics, modeling, cartography, databases, geographic contingencies (e.g., the modifiable areal unit problem), and much more. Identifying the appropriate method to use in any particular instance is often not an easy task (and one made harder in many cases by the inability to know exactly what the software program is doing). Not all methods are created equal, and the improper choice of a method can lead not only to error but also to outright misrepresentation or skewing of facts. This represents a serious flaw in current use of GSTs—the view that anyone can, for example, "do GIS." Uninformed use of GIS, software, and spatial analytical methods may be almost as evil as intentional misrepresentation, particularly if it results in misunderstandings of social justice or environmental protection issues. Raising the knowledge level of, first, geographers and then of the general public is a critical imperative, and one the geospatial technology community must address (Richardson and Solis 2004; Sui 2004b).

A Sea Change: The Perception of a Need for Security and the Role of GSTs

After the tragic events of 9/11, no one doubts that the age of surveillance, a geospatial-technology-driven Panopticon (Gray 2003; Koskela 2003), has arrived. "The very idea of surveillance evokes curiosity, desire, aggression, guilt, and, above all, fear" (Tabor 2001, 135), producing a digital objectification that results in a "more vicious use of space" (Wyly 2004, 93). Geospatial technologies are being harnessed in ever-increasing strength by those who seek to censure freedom in the name of safety (Crampton 2003; Richardson and Solis 2004). As Crampton observed, however, the role of modern GSTs such as GIS in surveillance and security follows in the footsteps of atlases developed in the 1800s. The technology may be new; the intent is not.

A recent geographical example of how perceptions have changed since 9/11 is clearly seen in reactions to Sean Gorman's 2004 Ph.D. thesis, which details the "physical" geography of the information infrastructure of the United States (e.g., fiber optic cables, switching centers). Prior to 9/11 all of the information he used in his research was available in the public domain or through a simple data request (Australian Broadcasting

Corp. 2004), and was of interest to few. After 9/11, however, Gorman's work became of such national concern that the thesis itself had to be held in a secure facility behind cipher locks; "companies want to seize it, government officials want to suppress it, and al Qaeda operatives—if they could get their hands on it—would find a terrorist treasure map" (Blumenfeld 2003, A01). As Vaz and Bruno (2003, 283) state, "consequently, nothing per se is a risk and, conversely, everything may become one if the appropriated techniques are historically invented and deployed."

Of course the changing perceptions of GSTs are not new. In 1967 a Yale University administrator closed the accounts associated with research efforts aimed at developing GIS software to support the 1970 American census (Dobson and Fisher 2003, 50). What was considered then as too great a risk for allowing an invasion into privacy is now considered a benign part of everyday life (e.g., who doesn't have a "preferred" client card that records every purchase they make, a card that makes the information collected by the census almost irrelevant to most market research firms today?). Where would the U.S. Census Bureau be today without such software? But then, would there be location-based service providers today if not for the research efforts and wealth of data provided by the Census Bureau?

Hey, Big Brother

Reconfigurations of data are not, however, the only post-9/11 fears we have to consider. The line between power and "care" is becoming increasingly nebulous (Vaz and Bruno 2003, 273). Surveillance can now reach from the smallest of places (e.g., RFID tags that can be invisibly embedded in clothing) to the widest of spaces (such as commercially-available high-resolution satellite imagery; see, e.g., Monmonier 2002). The ever-surveillant society (location-aware cell phones, video cameras, and facial recognition systems, etc.—the Panopticon's arsenal increases on an almost-daily basis) will enshrine our daily activities forever and mistakes will become permanent. Will such a legacy result in the creation of a blackmail society (Gray 2003, 324)? Will street people become further disassociated from society, their lives the focus of a permanent, ever-present, but unbidden reality show?

As we all become "digital individuals" (Curry 1997), over time our "data shadows" (Zook et al. 2004) will become our perfect simulacrums. This, of course, raises very serious concerns about privacy and civil liberties (Richardson and Solis 2004). It also opens up opportunities for some very insightful analyses. Consider, for example, the benefits that such data would bring to environmental health geographers. Being able to explore in detail people's life trajectories would greatly inform analyses such as the community-led study in West Islip, Long Island, New York, that seeks to understand the spatial tendencies and potential environmental causes of breast cancer (Kwan 2002b). Research by Kwan (2000) shows how such data can be used to explore gendered spaces and reveal contingencies that might otherwise remain invisible (e.g., two women both take drug X, but only the woman who as a child lived in a neighborhood that was routinely subjected to herbicide overspray develops cancer; neither event—taking drug X or being exposed to the herbicide—by itself would necessarily result in cancer, but the two events combined dramatically increase the likelihood of cancer).

The possibilities for insight are significant, particularly if we are able to navigate a respectful path through the landscape of moral and ethical dilemmas that are embedded in such data sets. As academic geographers, we need to explore those paths now if we are to be prepared to make respectful use of the research opportunities when they arise. There is also an urgent need to be vigilant, however, with respect to a societal shift that is occurring: information previously held in the public domain is increasingly being possessed by private concerns, and what should be a common or public good is more likely to become a private commodity (Sui 1998; Richardson and Solis 2004; Wyly 2004).

Closely related to the concept of digital individuals is that of "geoslavery," a term put forward by Jerome Dobson in 2002. Geoslavery is defined "as the practice in which one entity, the master, coercively or surreptitiously monitors and exerts control over the physical location of another individual, the slave" (Dobson and Fisher 2003, 47–48). This is seen as the ultimate threat of crossing that line separating power from care. There are many examples on the Internet of firms advocating the benefits of geoslavery,[1] suggesting that the market for such services is very wide. What will the long-term implications for society be, however, when everyone—from the child growing up to the senior being monitored by her children—knows that their every action is being recorded?

Close collaborations between academics and practitioners with respect to the social implications of GST need to be developed. All analyses and technologies have unintended consequences; products of these technologies can be used for good or not. It is up to us—those who produce the maps, who perform the spatial analyses, who develop the hardware and software—to consider and make known the consequences of our actions.

Increasingly it is becoming clear that geospatial technologies are being used by those in power to monitor, and even engender fear in, others, if only through development of a permanent sense of mistrust. Moreover, geospatial technologies are enabling far more people to abuse their powers, from the caring parent monitoring her child or aging mother, to the suspicious husband tracking his wife, to the employer monitoring employees even outside of working hours, to the government looking for the next terrorist (Dobson and Fisher 2003). Writings on geoslavery have been published (CNN 2003), but more outreach is needed to inform the public of the issues, both good and bad, surrounding geospatial technologies. For many it may be that "we do not know the beginning of the story, how the fearing was developed—how the unsafe came to be associated with place, how the cartography of real and potential danger, which informs conscious choices of daily access and movement, was formed" (Epstein 1997, 134), but for those informed of the implications and contradictions inherent in this new age of the Panopticon, the story is becoming all too clear.

A Way Ahead

Although geospatial technologies are the source of many of these new cartographies of danger, they can be used to address some of society's fears. We can use our knowledge and tools in a humanitarian fashion, for the greater good, and many people are actively pursuing such paths. Hope springs from a thousand lights, and what better way to illuminate the darkness? We can control how these cartographies of fear are reformed. We can work toward the incorporation of "social fabric," of social good, into technology.

Perceptions of a lack of safety in public spaces are partly a result of the segregation of activities in terms of class, gender, age, ethnicity, and type of occupation (Tiesdell and Oc 1998). We can use GIS to examine maps of fear, and contemplate reorganizations of space that have the potential to reduce those fears (Bichler-Robertson and Johnson 2001; Doran and Lees 2005). Urban planning could ensure that safe environments are created, ones that provide natural surveillance through an appropriate mix of land uses and a "natural animation" of the landscape (i.e., a mix of people, both present and visible).

Community groups throughout the world are using GSTs to help make their communities less dangerous (e.g., Elwood 2004; Lindenbaum 2006). Hopeworks,[2] in Camden, New Jersey, is one small example of residents hoping that by mapping dead streetlights in the Cramer Hill neighborhood the municipality will fix them sooner, thereby helping to alleviate the fears that people have when walking down darkened streets. There are hundreds, even thousands of projects like this across North America and Europe. Community-based projects are founded on hope, grounded in protecting the local area, putting forward minority perspectives, rebalancing the power base (see, e.g., the list of papers submitted for the NCGIA Specialist Meeting on "Empowerment, Marginalization, and Public Participation GIS"[3] or the many publications listed by Rambaldi 2006, from which it is apparent that Participatory GIS [PGIS] is rapidly overtaking Public Participation GIS [PPGIS] as the methodology of choice, especially in the developing world [e.g., Chambers 2006; Lindenbaum 2006]). Internationally, landmine-clearing exercises are another example of how socially-conscious geographers can redress some of the fears that are a direct result of the application of geospatial technologies during times of conflict (Samuel et al. 1998; see also the Landmine Monitor web site: http://www.icbl.org/lm/).

The Potential Tyranny of Space

Notions of space are being reconfigured in this age of the Panopticon. The role that space plays in a variety of disciplines is changing rapidly, in part because of the increased resolutions available (both spatial and temporal), and in part because of more sophisticated analytical capabilities that are available to the research community. In some fields, such as health geography, landscape ecology, and conservation biology, space is a relatively new concept that is increasingly becoming central; in other fields such as geodemographics, where space has always been a central element, its role is changing dramatically.

Places in space (e.g., a neighborhood, a city)—identified through cluster analyses of census data and, increasingly, other sources of information—have traditionally been the element of interest to geodemographers (Weiss 2000; Phillips and Curry 2003). People of like lifestyles occupied those spaces, and marketing was targeted to the average person living there. As our ability to reliably identify finer elements within space has increased, the focus of geodemographers has shifted to smaller groups. Now, with the ability to track individuals spatially and temporally, geodemographics has fully integrated Hägerstrand's space-time geography.

This emerging geography of difference, resulting from the abilities of corporations to finely determine their markets, can accentuate economic and social inequities (Sui 1998; Phillips and Curry 2003). Similar to the

outlawing of the practice of redlining in the United States, there is the need to ensure that GSTs are not used to further marginalize those already at the edges of society. Careful and considered spatial analysis would be one avenue of opposition to such forces, incorporated within a broad array of other socially-revealing research practices (e.g., Wyly 1998, 2004).

Health, for Example

Interestingly, while geodemographics are moving beyond neighborhoods, recent findings, identified through careful geospatial analyses, appear to indicate that neighborhoods do matter significantly to health, and that places can have long-lasting implications. For example, recent studies that estimate the effects of poor air quality on health clearly show there is a significant measurable impact that results from living adjacent to major highways, in particular for children (e.g., Hulsey et al. 2004; Reynolds et al. 2004; Zmirou et al. 2004). Should we seek alternative transportation systems (e.g., light rail), or reconfigure land uses so that these effects are minimized (e.g., Hulsey et al. 2004)? Should we attempt to distribute risks socially (Vaz and Bruno 2003)? All of this, the depth of the analysis, the shedding of light on new issues, is directly dependent on the power of geospatial technologies.

A very interesting analysis that shows the power of spatial analysis in understanding the role of place on health is that of Orforda et al. (2002). In their study on the lives and deaths of the people of London, they developed a geodatabase that included 1991 census data and data from Charles Booth's survey at the end of the nineteenth century into the social and economic conditions of Londoners. Using standardized mortality ratios derived for all causes of death between 1991 and 1995, Orforda et al. observed that "the geography of all causes of death for people over the age of 65 was more strongly related to the geography of poverty in the late 19th century than contemporary patterns of poverty" (Orforda et al. 2002, 25). The results of their analyses are intriguing, and deserve a considered follow-up in order to fully understand the dependencies that their work revealed (e.g., which remaining elements of the nineteenth century city are impacting today's population?).

The issues that surround GSTs, and that are engendered by them, have now grown to include "us." Study of the human genome has created new fears, ones that require quick moral and ethical actions if they are to enhance social justice and not promote inequality. Will a person's geographic profile become as important in the future as his genetic profile? Although it is in the future that the possible consequences of one's genetic profile will be revealed, it is in the present that its repercussions will be felt: "People will become patients before their time" (Jacob 1998, 102). With digital geospatial shadows it could be a location from one's past that could condemn your present "spatial" health.

As surveillance systems follow an individual's every move through space and time, recall that health geography does not have an expiry date. Will people be denied medical coverage because of the spaces they occupied throughout their lives? Such a prospect then becomes one of the more insidious aspects of the Panopticon. Not only will surveillance mold our activities into a constrained pattern, but our past geographies will truly come back to haunt us, much as they have for those who worked in the Hanford nuclear facilities (e.g., Gilbert, Cragle, and Wiggs 1995; Wing and Richardson 2005), but in far more subtle ways.

Contextualizing GIS

Spatial analysis in the future will be much more contextualized. GIS analysts will have at their disposal a multiplicity of information types (an expanded array of quantitative data, along with qualitative data such as still and moving images, anecdotal text, and voices), and the analytical framework within which the analyst works will include qualitative methods as well as a wide array of quantitative techniques (Wyly 2004). Forming an integral part of a multiple-methods approach to research, GSTs will be situated within a broader, socially-aware context (Harvey and Chrisman 1998; Philip 1998; Sui 2004a). A multiple-methods approach including GSTs can, for example, illuminate how different groups—even though reaching a consensus on an issue (e.g., an agreement with respect to the definition of, say, what is a wetland)—can still hold very different views as to the geography of that issue (e.g., areas identified as "wetlands" on their maps have very little overlap). Illuminating such contrasts is clearly a benefit of moving from a qualitative, textual perspective to a quantitative, graphic perspective (Harvey and Chrisman 1998).

As more voices are included in the analytical framework, the overall result is less ambiguity and fewer chances to misrepresent. As McLafferty (1995, 440) notes: "by coupling the power of the general [i.e., quantitative methods including GIS] with the insight and nuance of the particular [i.e., interviews, participant observation], such research illuminates people's lives and the larger contexts in which they are embedded." Exploring nonspatial information relations using spatial

technologies will also help blur the boundaries between methodologies (Sui 2004b).

Modern quantitative approaches (e.g., geographically-weighted regression; local indicators of spatial association, LISA) allow for the local to emerge, and can reveal subtle spatial influences that previously were masked within broader regional models (Rees and Turton 1998). Interactive maps can be made much more intelligent, easily allowing for alternative symbolizations to be used, for pictures (both moving and still) to be embedded, for narratives to be accessible, for metadata to be out front (and therefore the uncertainties to be clearly laid out). With personal locational technologies, the maps can also be tailored to the individual's current space and time, and designed to suit their preferences (Zook et al. 2004).

A Call to Action

Mackie (2003) has stated that "if our communities are to survive, if compassion is once again to take root in public life, and cohesion is to be maintained, we have no choice but to overcome the dominance of fear and to reassert hope as a key driver of our human condition." The community of geographers is well placed to be key drivers in this journey of hope. Geography is probably the best-situated discipline within which both theoretical and practical studies of geospatial technologies can be conducted and harnessed for the good of society (Richardson and Solis 2004). To paraphrase a common GIS anecdote, within the discipline the islands of researchers (from social theorists to hard-core spatial analysts) are coalescing into a synergistic mainland community (e.g., Clark 1998; Harvey and Chrisman 1998; Openshaw 1998; Philip 1998; Sui 1998; Hoeschele 2000; Sieber 2000; Kwan 2002a, 2002b). There is still a long way to go before the empowering and democratizing role of geospatial technologies is functionally established, before the "social" is deeply embedded within GIS (e.g., Sui's [2004b] Humanistic GIScience), and the impacts of GSTs on society are sufficiently understood. Many critical debates still need to be held, but the movement to that mainland has been initiated and the direction is clear. To achieve those hopes, it is important that the potential social consequences of GIS analyses be explicitly considered ante- and post-mortem, and that more human geographers become involved in GIS analyses and development so that they can shape its future (Openshaw 1998; Sui 2004a). As geographers, we need to demonstrate the commitment to the public good that is inherent in geospatial technologies.

That commitment, to me, is the single most important and glaring gap in the social evolution of GSTs: some human geographers themselves are fearful of GSTs, many do not fully understand them, and, of greater consequence, too many treat them as "just a technique" (Openshaw 1998; Sui 2004b). This ignorance is dangerous and is a form of social irresponsibility. GSTs are not simply (nor simple) techniques. With the appropriate knowledge-base and expertise, they are entire new ways of seeing (Goodchild 2000; Zook et al. 2004). Without the proper expertise and knowledge base, methods can be improperly chosen, will not draw out critical information, and could ultimately improperly influence such key areas as social justice and environmental health policy. Theory drives GSTs, and that theory evolves. It requires social constraint in order to maintain a sound hopeful path toward the future.

The new "topography" of spatial technologies that is being formed is not yet independent of its past, although we can work to remodel the landscape to suit the enlightened perspectives of the present, and many people are actively doing so. Regardless of how we now move forward to weave the social into GSTs, historical contingencies still play a significant role in the use and fear of geospatial technologies today, and will do so for some time. As digital geographies are still reflective of the past "unevenness" in the experienced economic and social (and gender, ethnic, race, age) geographies of the world (Zook et al. 2004), so are GSTs reflective of their pasts (e.g., Goodchild 1988; Rhind 1988). The geospatial technologies of the future should look very different from those in the fore today. The social will be embedded in the technology, and the spatial technologies will themselves be embedded, being one of many complementary methods used in an analysis (Wyly 2004).

Geospatial technologies are not good or evil, but if naively used they can generate fear and build power bases. If we allow those in power to appropriate the technology and restrict access to geospatial information, significant opportunities for generating "good" will be lost. Empowerment through the democratization of spatial information—the development of a spatial information commons (Onsrud et al. 2004)—is occurring in many communities, and is one clear example of the good that geospatial technologies can produce. It is apparent that we need to be vigilant in monitoring how geospatial technologies are being used, and sometimes we may need to become activists in order to ensure that future generations do not live under the tyranny of geography but rather benefit from the spatially-informed analyses that geospatial technologies enable us to perform (Richardson and Solis 2004; Sui 2004b).

Embedded in many of the topics discussed in this article are concerns related to the "grain" at which our

life's history is being recorded (our digital shadows). As finer grained geospatial data are collected, stored, and analyzed, personal privacy issues come to the fore. Locational privacy, or the lack of spatial anonymity, is an issue that urgently needs to be addressed: should we all have the right to locational privacy, similar to our private property rights; should it be a basic human right (Monmonier 2002; Taipale 2004; Center for Strategic and International Studies 2005)?

As a call to action, several avenues are clear: there is a continued need for critical studies of, and informed studies using, geospatial technologies, as these are vital to expanding the use of geospatial technologies for the common good. When finely grained spatial and temporal data are routinely available, geographers must fully engage in thinking deeply on the moral and ethical dilemmas that lie ahead. Outreach activities by geographers, informing the public on the abuses and proper uses of maps and spatial analysis, will be increasingly important given the ever-widening use of geospatial technologies by the public. Becoming involved in geospatial initiatives in the local community will highlight the strengths of the discipline. Working to include alternative forms of data (e.g., images, voices), as well as developing more nuanced quantitative data analyses within geospatial technologies, is an important action that may require working closely with the commercial side of GSTs. Developing metadata standards for qualitative data while respecting the context and sensitivities of local communities is another area of research and outreach. Daniel Sui (2004b, 68) points out that "geography is well positioned to play a leading role in the third culture [one that joins science and literature] if we can combine analysis with synthesis, scientific rigor with artistic sensitivity, and pure intellectual pursuits with dominant social concerns of our time."

Geographers must also work closely with those in allied fields, such as urban planning, so that the knowledge gained through the sophisticated use of geospatial technologies in fields such as health geography, crime geography, and environmental justice can be applied for the good of society. Human geographers need to become more aware of the evolution of spatial technologies and the theories behind them. They need to develop familiarity with GSTs, and GIS in particular, in order to understand how such technologies and techniques can help inform their research, and how their research can inform those using and developing geospatial technologies. The GST community must also remain open to those outside of their community, and strive to both overcome the fears and promolgate the hopes inherent in geospatial technologies.

Acknowledgments

This article was first presented as part of the Plenary of the American Association of Geographers Annual General Meeting held in Denver, Colorado, in 2005. Discussions with Mike Goodchild and Don Janelle helped form some of the directions in this article. The comments of the four anonymous reviewers and Audrey Kobayashi are appreciated. The interest and guidance shown by Victoria Lawson, in first inviting me to participate in the plenary, and then while revising the article, is sincerely appreciated.

Notes

1. Examples include Teen Arrive Alive, http://www.teenarrivealive.com/, and Digital Angel, http://www.digitalangel.net.
2. Website: http://www.hopeworks.org/gservices.html.
3. Website: http://www.ncgia.ucsb.edu/varenius/ppgis/papers/.

References

Australian Broadcasting Corporation. 2004. *US critical infrastructure*. ABC Radio National: The Buzz 14 February 2004. (Transcript of an interview by Richard Aedy with Sean Gorman.) Available at http://www.abc.net.au/rn/science/buzz/stories/s1047647.htm (last accessed 27 November 2006).

Bakker, K. J. 2003. *An uncooperative commodity: Privatising water in England and Wales*. Oxford, U.K.: Oxford University Press.

Bichler-Robertson, G., and M. Johnson. 2001. Connecting environmental cues to commercial burglary concentrations: Combining theory and practice into a blended approach. *10th International Seminar on Environmental Criminology and Crime Analysis, Liverpool, 17–20 June*. Available at http://cjrc.csusb.edu/CPAL/10thannual.pdf (last accessed 31 January 2007).

Blumenfeld, L. 2003. Dissertation could be security threat: Student's maps illustrate concerns about public information. *Washington Post* 8 July:A01.

Bowers, K., and A. Hirschfield. 1999. Exploring links between crime and disadvantage in north-west England: An analysis using geographical information systems. *International Journal of Geographical Information Sciences* 13:159–84.

Bruce, C. W. 2001. A thousand words for a picture: Is the overvaluation of GIS disrupting a critical balance in crime analysis? *Crime Analyst's Round Table V* 1.0, Spring 2001. Available at http://www.macrimeanalysts.com/rt/f2cb1.htm (last accessed 27 November 2006).

Center for Strategic and International Studies Homeland Security Program. 2005. *Security controls on scientific information and the conduct of scientific research*. A White Paper of the Commission on Scientific Communication and National Security. http://www.csis.org/media/csis/pubs/0506_cscans.pdf (last accessed 27 November 2006).

Chambers, R. 2006. Participatory mapping and geographic information systems: Whose map? Who is empowered and who disempowered? Who gains and who loses? *The Electronic Journal of Information Systems in Developing Countries [EJISDC]* 25 (2): 1–11. Available online at http://www.

ejisdc.org/ojs2/index.php/ejisdc/article/viewFile/238/159 (last accessed 31 January 2007).

Chisholm, M., and R. Cohen. 2005. The neighborhood project. http://hood.theory.org/ (last accessed 27 November 2006).

Clark, M. J. 1998. GIS—Democracy or delusion? *Environment and Planning A* 30:303–16.

CNN. 2003. *Will GPS tech lead to "geoslavery"?* CNN.com Technology Section 11 March 2003, http://www.cnn.com/2003/TECH/ptech/03/11/geo.slavery.ap/ (last accessed 27 November 2006).

Crampton, J. W. 2003. Cartographic rationality and the politics of geosurveillance and security. *Cartography and Geographic Information Science* 30:135–48.

Curry, M. R. 1997. The digital individual and the private realm. *Annals of the Association of American Geographers* 87:681–99.

Dicken, P. 1994. The Roepke Lecture in Economic Geography. Global-local tensions: Firms and states in the global space-economy. *Economic Geography* 70:101–28.

Dixon, D. P., and J. P. Jones III. 1998. My dinner with Derrida, or spatial analysis and poststructualism do lunch. *Environment and Planning A* 30:247–60.

Dobson, J. E., and P. F. Fisher. 2003. Geoslavery. *IEEE Technology and Society Magazine* 22 (1): 47–52.

Dodge, M., and R. Kitchin. 2005. Code and the transduction of space. *Annals of the American Association of Geographers* 95 (1): 162–80.

DoL. 2004. Department of Labor, http://www.doleta.gov/BRG/Indprof/Geospatial.cfm (last accessed 27 November 2006). (The quotation is from http://www.doleta.gov/WHATS NEW/new_releases/september2804-Geospatial%20Industry. cfm).

Doran, B., and B. Lees. 2005. Investigating the spatiotemporal links between disorder, crime and fear of crime. *The Professional Geographer* 57:1–12.

Dorling, D., and M. Shaw. 2002. Geographies of the addenda: Public policy, the discipline, and its (re)'turns.' *Progress in Human Geography* 26:629–41.

Elwood, S. 2004. Neighborhood revitalization through "collaboration": Assessing the implications of neoliberal urban policy at the grassroots. *GeoJournal* 58 (2/3): 121–30.

———. 2006. Beyond cooptation or resistance: Urban spatial politics, community organizations, and GIS-based spatial narratives. *Annals of the Association of American Geographers* 96 (2): 323–41.

Epstein, D. 1997. Abject terror: A story of fear, sex, and architecture. In *Architecture of fear*, ed. N. Ellin, 133–42. New York: Princeton Architectural Press.

Erle, S., R. Gibson, and J. Walsh. 2005. *Mapping hacks: Tips & tools for electronic cartography*. Sebastopol, CA: O'Reilly Press.

Feenberg, A. 1991. *Critical theory of technology*. Oxford, U.K.: Oxford University Press.

Flowerdew, R. 1998. Reacting to ground truth. *Environment and Planning A* 30:289–301.

Gersmehl, P. J. 1997. Review of *Atlas of American agriculture: The American cornucopia* (by R. Pillsbury and J. W. Florin, 1996. New York: Macmillan). *Journal of Geography* 96 (3): 177–78.

Gilbert, E. S., D. L. Cragle, and L. D. Wiggs. 1995. Updated analyses of combined mortality data for workers at the Hanford Site, Oak Ridge National Laboratory, and Rocky Flats Weapons Plant. *Radiation Research* 141 (1): 124–26.

GISCI. 2006. *A GIS code of ethics*. GIS Certification Institute. Available at http://www.gisci.org/code_of_ethics.htm (last accessed 31 January 2007).

Goodchild, M. F. 1988. Stepping over the line: Technological constraints and the new cartography. *American Cartographer* 15:311–19.

———. 2000. Communicating geographic information in a digital age. *Annals of the Association of American Geographers* 90:344–55.

Gray, M. 2003. Urban surveillance and Panopticism: Will we recognize the facial recognition society? *Surveillance & Society* 1 (3): 314–30.

Gregory, D. 1994. *Geographical imaginations*. Cambridge, MA: Blackwell.

Harvey, F., and N. Chrisman. 1998. Boundary objects and the social construction of GIS technology. *Environment and Planning A* 30:1683–94.

Herb, G. H. 1999. Before the Nazis: Maps as weapons in German nationalist propaganda. *Mercator's World* 4 (3): 26–31.

Herdt, R. W. 2004. Food shortages and international agricultural programs. *Critical Reviews in Plant Sciences* 23:505–17.

Hoeschele, W. 2000. Geographic information engineering and social ground truth in Attappadi, Kerala State, India. *Annals of the Association of American Geographers* 90:293–321.

Hulsey, B., E. Hopkins, E. Olson, E. Burg, and M. Carlson. 2004. *Highway health hazards*. The Sierra Club Foundation. Available at http://www.sierraclub.org/sprawl/report04_highway health/report.pdf (last accessed 27 November 2006).

Hyndman, J. 2000. *Managing displacement: Refugees and the politics of humanitarianism*. Minneapolis: Minnesota University Press.

Jacob, F. 1998. *Of flies, mice, and men*. Cambridge, U.K.: Cambridge University Press.

Katz, C. 2001. On the grounds of globalization: A topography for feminist political engagement. *Signs: Journal of Women in Culture and Society* 26 (4): 1213–34.

Klinkenberg, Brian. 2003. The true cost of spatial data in Canada. *Canadian Geographer* 47 (1): 37–49.

———, ed. 2006. *E-Flora BC: Atlas of the plants of British Columbia* [www.eflora.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver (last accessed 27 November 2006).

Koskela, H. 2003. "Cam Era": The contemporary urban Panopticon. *Surveillance & Society* 1 (3): 292–313.

Kwan, Mei-Po. 2000. Interactive geovisualization of activity-travel patterns using three-dimensional geographical information systems: A methodological exploration with a large data set. *Transportation Research C* 8:185–203.

———. 2002a. Feminist visualization: Re-envisioning GIS as a method in feminist geographic research. *Annals of the Association of American Geographers* 92:645–61.

———. 2002b. Is GIS for women? Reflections on the critical discourse in the 1990s. *Gender, Place and Culture* 9: 271–79.

Le Billon, P. 2001. The political ecology of war: Natural resources and armed conflicts. *Political Geography* 20:561–84.

Lindenbaum, S. 2006. *Mapping for advocacy: Case studies*. Open Society Institute. Available online at http://www.soros.org/initiatives/information/focus/communication/articles_publications/publications/gis_20060412 (last accessed 27 November 2006).

Mackie, G. 2003. Welcome and introduction. Adelaide Festival of Ideas 2003, 10–13 July. Available at http://www.adelaidefestival.com.au/archives/ideas2003/foi2003.asp (last accessed 27 November 2006).

Martin, R. L. 2001. Geography and public policy: The case of the missing agenda. *Progress in Human Geography* 25:189–210.

———. 2002. A geography for policy, or a policy for geography? A response to Dorling and Shaw. *Progress in Human Geography* 26:642–44.

Massey, D. 2002. Geography, policy and politics: A response to Dorling and Shaw. *Progress in Human Geography* 26:645–56.

McLafferty, S. L. 1995. Counting for women. *The Professional Geographer* 47:336–443.

Mediamatic. 2005. *Triggered by RFID—Crash Course*. Available at http://www.mediamatic.net/artefact-200.9210.html (last accessed 27 November 2006).

Monmonier, M. 1996. *How to lie with maps*, 2nd ed. Chicago: University of Chicago Press.

———. 2002. *Spying with maps: Surveillance technologies and the future of privacy*. Chicago: University of Chicago Press.

Obermeyer, N. J. 1995. The hidden GIS technocracy. *Cartography and GIS* 22(1):78–83. Available at http://www.geo.wvu.edu/i19/papers/hidntech.html (last accessed 25 June 2005).

Onsrud, H., G. Camara, J. Campbell, and N. S. Chakravarthy. 2004. Public commons of geographic data: Research and development challenges. In *Geographic information science*, ed. M. J. Egenhofer, C. Freska, and H. J. Miller, 223–38. Lecture Notes in Computer Science #3234. Berlin: Springer-Verlag.

Openshaw, S. 1998. Towards a more computationally minded scientific human geography. *Environment and Planning A* 30:317–32.

Orforda, S., D. Dorling, R. Mitchell, M. Shawd, and G. D. Smith. 2002. Life and death of the people of London: A historical GIS of Charles Booth's inquiry. *Health & Place* 8:25–35.

Philip, L. J. 1998. Combining quantitative and qualitative approaches to social research in human geography—An impossible mixture? *Environment and Planning A* 30:261–76.

Phillips, D. J., and M. Curry. 2003. Privacy and the phenetic urge: Geodemographics and the changing spatiality of local practice. In *Surveillance as social sorting: Privacy, risk, and automated discrimination*, ed. D. Lyon, 137–52. London: Routledge.

Pickles, J. 1991. Geography, GIS, and the surveillant society. *Papers and Proceedings of the Applied Geography Conference* 14:80–91.

———, ed. 1995. *Ground truth: The social implications of geographic information systems*. New York: Guilford.

Rambaldi, G. 2006. *PPGIS, PGIS, CiGIS, MiGIS, P3DM, community mapping, counter mapping, tenure mapping, asset mapping—Virtual library*. Available at http://www.iapad.org/bibliography.htm (last accessed 27 November 2006).

Rees, P., and I. Turton. 1998. Guest editorial. *Environment and Planning A* 30:1835–38.

Reynolds, P., J. Von Behren, R. Gunier, and O. Raaschou-Nielsen. 2004. Epidemiologic evidence for air pollution and childhood cancer. *International Scientific Conference on Childhood Leukaemia, Westminster, London, 6–10 September*. Available at http://www.leukaemiaconference.org/programme/speakers/day4-reynolds.pdf (last accessed 27 November 206)

Rhind, D. W. 1988. Personality as a factor in the development of a discipline: The example of computer-assisted cartography. *American Cartographer* 15:277–90.

Richardson, D., and P. Solis. 2004. Confronted by insurmountable opportunities: Geography in society at the AAG Centennial. *The Professional Geographer* 56 (1): 4–11.

Rushkoff, D. 2005. Honey, I geotagged the kids. *The Feature*. Available at http://www.thefeaturearchives.com/101490.html (last accessed 27 November 2006).

Samuel, S., J. Gentile, G. Gustafson, M. Kimsey, H. Kraenzle, J. Wilson, and S. Wright. 1998. Use of imagery and GIS for humanitarian demining management. *The Journal of Humanitarian Demining* 2 (1): N.P. Available at http://maic.jmu.edu/journal/2.1/gustafson.htm (last accessed 27 November 2006).

Schuurman, N. 2000. Trouble in the heartland: GIS and its critics in the 1990s. *Progress in Human Geography* 24 (4): 569–90.

Seppälä, M. 1999. Women's city: Geography of fear? *Universitas Helsingiensis* 4. Available at http://www.helsinki.fi/lehdet/uh/499c_l.html (last accessed 27 November 2006).

Sieber, R. E. 2000. Conforming (to) the opposition: The social construction of geographical information systems in social movements. *International Journal of Geographical Information Science* 14:775–93.

Smith, N. 1992. Real wars, theory wars. *Progress in Human Geography* 16 (2): 257–71.

Sui, D. Z. 1998. Deconstructing virtual cities: From unreality to hyperreality. *Urban Geography* 19:657–76.

———. 2004a. GIS, cartography, and the "Third Culture": Geographic imaginations in the computer age. *The Professional Geographer* 56 (1): 62–72.

———. 2004b. The geography of the United States in the year 2000: Science, predictability, and public policy in an age of uncertainty. *The Professional Geographer* 56 (1): 73–75.

Tabor, P. 2001. I am a videocam. In *The unknown city: Contesting architecture and social space*, ed. I. Borden, J. Kerr, J. Rendell, and A. Pivaro, 122–37. Cambridge, MA: MIT Press.

Taipale, K. A. 2004. Technology, security and privacy: The fear of Frankenstein, the mythology of privacy and the lessons of King Ludd. *Yale Journal of Law and Technology* 7:123–221.

Tiesdell, S., and T. Oc. 1998. Beyond "fortress" and "panoptic" cities—Towards a safer urban public realm. *Environment and Planning A* 25:639–55.

Vaz, P., and F. Bruno. 2003. Types of self-surveillance: From abnormality to individuals "at risk." *Surveillance & Society* 1 (3): 272–91.

Waters, N. 2004. GIS and Martus: Technology with a conscience. *GeoWorld* 17 (3). Available at http://www.geoplace. com/gw/2004/0403/0403edge.asp (last accessed 27 November 2006).

Weiss, M. J. 2000. *The clustered world—How we live, what we buy, and what it all means about who we are*. New York: Little, Brown.

Wing, S., and D. B. Richardson. 2005. Age at exposure to ionising radiation and cancer mortality among Hanford workers: Follow up through 1994. *Occupational and Environmental Medicine* 62:465–72.

Wyly, E. K. 1998. Containment and mismatch: Gender differences in commuting in metropolitan labor markets. *Urban Geography* 19:395–430.

———. 2004. Geographies of the United States in the year 2004. *The Professional Geographer* 56 (1): 91–5.

Zmirou, D., S. Gauvin, I. Pin, I. Momas, F. Sahraoui, J. Just, and Y. Le Moullec, et al. 2004. Traffic related air pollution and incidence of childhood asthma: Results of the Vesta case-control study. *Journal of Epidemiology and Community Health* 58:18–23.

Zook, M., M. Dodge, Y. Aoyama, and A. Townsend. 2004. New digital geographies: Information, communication, and place. In *Geography and technology*, ed. S. D. Brun, S. L. Cutter, and J. W. Harrington, 155–76. Amsterdam: Kluwer Academic.

Correspondence: Department of Geography, University of British Columbia, 1984 West Mall, Vancouver, BC V6T 1Z2, e-mail: brian@geog.ubc.ca.