Knowledge Production through Critical GIS: Genealogy and Prospects

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Abstract

Over the last decade, a new research program has emerged at the interface between geographic information science and geographical social theory, now called critical GIS. In this article I analyse the emergence of critical GIS as an example of knowledge production in geography. I examine its genealogy, highlighting the key debates, events, and individuals instrumental in facilitating a rapprochement between two initially opposed scholarly communities and tracing the directions that this has since taken. Addressing its current incarnation as critical GIS, I relate it to the critical theory tradition in the social sciences and assess the pertinence of the term "critical" for describing the epistemology and philosophy of critical GIS. I examine how technology, the geography of GIS research, and politics are shaping the future trajectory of critical GIS. Drawing on Helen Longino's vision for strong knowledge production, I argue that the future of critical GIS will depend on the ability of its practitioners to remain conscious and reflexively critical of their own emergent presuppositions.

Keywords: geographic information science, critical theory, critical GIS, knowledge production

Résumé

Au cours des dix dernières années, un nouveau programme de recherche est apparu à la croisée des chemins entre la science de l'information géographique et la théorie sociale de la géographie. Il s'agit des SIG critiques. J'ai analysé la montée des SIG critiques en tant qu'exemple de la progression de la connaissance en géographie. J'ai examiné leur origine et j'ai mis en évidence les principaux débats, les événements et les personnes ayant joué un rôle instrumental dans le processus, afin de faciliter un rapprochement entre deux communautés de chercheurs qui avaient des idées contradictoires au départ et de revoir le chemin parcouru. J'établis aussi un lien avec la tradition de la théorie critique en sciences sociales et j'évalue la pertinence du terme « critique » pour décrire l'épistémologie et la philosophie des SIG. J'examine comment la technologie, la géographie de la recherche en matière de SIG et les politiques déterminent la future trajectoire des SIG critiques. En me basant sur la vision d'Helen Longino sur la production de connaissances exactes, j'émets une hypothèse selon laquelle l'avenir des SIG critiques dépendra de la capacité de ses adeptes à garder une certaine ouverture d'esprit quant à leurs propres hypothèses.

Mots clés: science de l'information géographique, théorie critique, SIG critique, production de la connaissance

It has been more than a decade since the first attempts to catalyse a new research agenda drawing on the combined strengths of GIS specialists and social theoretic human geographers. Notwithstanding initial resistance from within both communities, and awkward opening conversations at Friday Harbor, WA, in November 1993, this initiative has prospered beyond the wildest dreams of its proponents. In this article, I seek to narrate and assess the trajectory of this path of knowledge production, which recently has come to be called critical GIS. In doing so,

I consider critical GIS as a *research program*. I take the term from Ian Hacking (1983), who defines a research program as "a specific attack on a problem using some well-defined . . . ideas" (115–16). Hacking distinguishes his usage from Imré Lakatos's (1970) *research programme,* which articulates a longer historical perspective on communities of scholars sharing a common project of knowledge production.[1] Both philosophers see knowledge production as a path-dependent process, but they differ in their assessment of the overall rationality of the path taken. Lakatos believes that research programmes pursue a rational, even logico-deductive, approach to scientific knowledge production, with "progressive" programmes replacing "degenerative" ones. Hacking finds Lakatos's claims for rational progress obscure and prefers to remain agnostic about whether research programs pursue the best possible path (Hacking 1983, 1999; Sheppard 1995b). Both agree, however, that research programs function by developing a negative feedback loop to exclude knowledge that does not fit. Thus Lakatos describes research programmes as built on a negative heuristic of "hard–core" propositions, considered irrefutable by the community, that frames a positive heuristic setting the agenda of problems to be worked on.

My first purpose here is to trace the emergence of critical GIS as a research program, narrating how, by challenging the central propositions of and gaining selective support from mainstream GIS, it has gained traction as a particular trajectory of knowledge production. My second purpose is to critically reflect on the knowledge produced along this trajectory. Whereas Lakatos might infer that observable progress, that is, the undoubted success of critical GIS as a research program, is an indicator of its superiority, I incline to the position of Hacking. Three decades of science studies have shown Lakatos's inference to be problematic because of the socially constructed nature of knowledge. Thus I consider critical GIS – and, indeed, any research program – as articulating a " 'local epistemology" whose rationality cannot be inferred from its popularity. Helen Longino (2002) coins the term "local epistemology" to refer to a situated understanding of the subject at hand, grounded in a set of methodological and substantive assumptions with respect to which that account is persuasive. As both Hacking and Longino suggest, successful trajectories of knowledge production frequently entail the foreclosing or marginalizing of alternatives. Thus social critics of GIS set out to challenge the shared core propositions of GIS research, with notable success, engendering a new research program with its own foreclosed alternatives and unacknowledged " 'hard-core" propositions. By highlighting these, I seek to deconstruct tendencies to treat the chronology from mainstream GIS to GIS and society and critical GIS as a teleological narrative of progress, thereby opening critical space to consider alternative futures.

My assessment is necessarily situated and provisional. It is situated by my own positionality within these debates and as an Anglo-American geographer, long in the tooth, with a predisposition for quantitative methodologies and post-positivist epistemologies. It is provisional because the cusp in space-time from which any account is offered is a moment of ambiguity. Like the two faces of the Roman god Janus, I am looking backwards and forwards. The past is given, ready-made, and a truth-like narrative of progress: foregone opportunities have disappeared from view, and what did happen appears as the only possibility. The future is possibility, in the making, and uncertain: nothing is yet foregone (Latour 1987). Too much attention to the past (Hacking 1983) creates a historicist perspective that evaluates progress only in terms of our ability to make good on that past. It also runs the danger of rehearsing yesterday's news. Even during the decade-long life of critical GIS, information technology, GIS, and human geography have undergone substantial changes that shift the terms of debate. These call into question presuppositions about the technology, the geography of knowledge production, and the science and politics at the centre of this research program. Highlighting alternative pasts, and presents, pushes our thinking to be less historicist and more open to alternative futures (Chakrabarty 2000). At the same time, the influence of past trajectories on future possibilities cannot be ignored. By avoiding teleological accounts of knowledge production, I seek a constructive but critical assessment that I hope will catalyse debate about the future of this research program.

The Past: GIS and Society[2]

The rapid growth in the 1970s and 1980s of geographical information systems (GIS) as an area of research, application, student interest, and influence within geography – marked by the 1987 founding of the National Center for Geographic Information and Analysis (NCGIA) – caused a stir. Ambitious claims were made about how GIS was making possible a new integrated and scientific geography (Dobson 1983; Openshaw 1991). Such claims, published at a time when human geographers had been moving substantially away from the positivist and critical rationalist approaches articulated by such proponents, catalysed a series of critical responses (reviewed in Pickles 1995b, 1999). These criticisms focused on both epistemological and practical implications of the spreading influence of GIS within geography.

Epistemologically, GIS was seen by many as a Trojan horse for the reassertion of broadly positivist approaches within human geography, because of its quantitative and empirical nature. Arguing that geography was too complex and varied a discipline to be analysed with this

approach alone, and undermining claims that positivist science is foolproof, universal, and objective, critics argued that GIS was in danger of overpowering post-positivist approaches, thereby circumscribing geography's ability to make sense of the world.[3] Social theorists also argued that this kind of scientific approach reified the status quo, reinforcing an empiricist epistemology that rules out from geography the investigation of other possible worlds than those we live in. They also argued that certain conceptions of space (particularly, geometric and relative space) and certain forms of reasoning (particularly, Boolean logic) are embedded within GIS, making it unable to represent adequately either non-European conceptions of space or the communicative rationality of everyday life (Habermas 1984, 1985; Rundstrom 1995; Sheppard 1995b).

Politically, critics argued that increased use of GIS in society would likely enhance current social and geographical inequalities because social actors have unequal access to GIS, thus applying broader concerns about an emerging digital divide to GIS. Wealth, gender, race, and geographic location are strongly correlated with access to the necessary equipment and training and with comfort in working with GIS. As a consequence, they argued, GIS facilitates practices, by those with access to the technology, of surveillance, social engineering, opinion formation, and warfare (Pickles 1991; Smith 1992; Lake 1993).

These critical attacks provoked equally sharp responses from GIS specialists, who found the critiques simplistic, unduly pessimistic and even paranoid, and indicating a lack of understanding of and experience with GIS or a lack of patience or aptitude for the rigours of science. They also resented the implication that GIS specialists are unconcerned with social issues and unaware of the social implications of science. At the same time, they saw such criticisms as a minor irritation that could be ignored, given the growing interest in GIS among both students and practitioners. As a consequence, between 1983 and 1993 there was little communication between what Pickles (1999) calls two cultures of indifference within geography: those critical of and those specializing in GIS.

This intellectual divide was challenged at Friday Harbor in 1993, when the NCGIA sponsored a conference for GIS specialists and social theorists seeking a more constructive engagement. The conference brought together prominent researchers from both camps (Poiker and Sheppard 1995). Notwithstanding some early tensions, caricatures broke down as participants came to know and appreciate the breadth of skills and interests of those coming from the other side. A common desire among those present to learn from one another stimulated development of a GIS and society research agenda, formulated at a second meeting in Annandale, MN, in February 1995. A new NCGIA initiative was launched whose proposed agenda contained seven themes (Harris and Weiner 1996):

- The social history of GIS as a technology
- The relevance of GIS for community and grassroots perspectives and life-worlds
- Issues of privacy, access to spatial data, and ethics
- The gendering of GIS
- GIS, environmental justice, and political ecology
- GIS and the human dimensions of global change
- Alternative kinds of GIS

The NCGIA initiative was one of several forums within which an active research program in GIS and society emerged, with collaboration taking a variety of forms: joint research by GIS specialists and social theorists; jointly organized sessions at GIS and geography conferences; creating forums for debate by inviting members of the ''opposite'' camp to participate in predominantly GIS or social theory initiatives (e.g., Pickles 1995a, 1999; Wright, Goodchild, and Proctor 1997); and new conferences. For example, the NCGIA's Varenius Project catalysed three workshops under the auspices of its Geographies of the Information Society theme: accessibility in the information age; place and identity in a digital society; and empowerment, marginalization, and public participation GIS (Sheppard and others 1999). A first international conference, Geographic Information and Society, was also held in Minneapolis, MN, in June 1999. The space for engagement between previously polarized fields of research created by these initiatives attracted new participants, seeking an audience for research of this kind that they were already involved in. Young scholars in particular, no longer feeling compelled to identify themselves as either geographic information scientists or social theorists, creatively acquired substantial expertise in both areas. In 1998, the University Consortium for Geographic Information Science included a fivefold GIS and society research agenda within its definition of GIS research: critical social theory, social history of GIS, legal and ethical issues, institutional issues, and public participation GIS (PPGIS) (Elmes and others 2005).

By the end of the 1990s, the constructive engagement meant that overlapping cultures of respect were replacing separate cultures of indifference, notwithstanding the continuing reluctance of some influential critical geographers or GIS specialists to participate. Tensions between different perspectives remain. For example, the renaming of GIS as ''geographic information science'' revived concerns about what is meant by ''science'' (Pickles 1997). Yet the tone of debate had shifted to a search for common ground, much to the relief of graduate students who no longer felt compelled to choose between GIS and critical human geography (Sheppard and others 1999). It is this new generation, trained in new courses on GIS

and society, that has been most vocal in seeking to break down any vestiges of a divide between these two sub-disciplines (cf. Schuurman 2000).

The shift from debate and critique, in which possibilities were suggested and individual cases cited to bolster their plausibility, to new concrete research remains shaped by the origins of this research program as two separate fields of study. This has placed the nexus between GIS and society at the centre of the research agenda. The relationship between GIS and society is dialectical (Sheppard 1995b). GIS, like any technology, has taken a form that reflects the social context in which it was developed. In turn, GIS shapes society itself. As the two co-evolve, each changes as a result of this interdependence. In practice, however, much of the research carried out under the ''GIS and society'' banner has either looked at the impact of society on GIS or looked at the impact of GIS on society – with much less attention to the former relationship.

HOW SOCIETY SHAPES GIS

The starting point of this research has been the proposition that, as for technological change in general, the evolution of GIS has followed only a restricted number of the many paths that could have developed – paths selected as a result of the societal context (Sheppard 1995b). On the one hand, research has investigated the evolution of the software and hardware itself, such as the rise to dominance of layer-based GIS during the 1980s – a technology that still dominates practical applications. This research has closely examined processes of technological development at key sites and moments (bifurcation points) when paths of future development were set and has speculated on the ''paths not taken'' – the alternative designs that did not get off the ground to shape the developmental path of mainstream GIS. The roles of key individuals, technical barriers, disciplinary traditions, and broader social forces in shaping paths of development have been analysed (Chrisman 1987; Curry 1998; Harvey 1998; Cloud and Clarke 1999; Schuurman 1999, 2001; McHaffie 2000).

Increasingly, those studying social influences on GIS have now broadened their focus beyond the software, employing the insight from science studies that technology cannot be divorced from the practices of those utilizing it (cf. Latour and Woolgar 1979; Callon, Law, and Rip 1986; Pickering 1995). In this view, GIS is not just the software purchased by users but also how it is deployed and the local technological adaptations by users, learning-by-doing, as they attempt to adapt standardized software to their particular needs. Such studies emphasize how the social and institutional context shapes GIS-related practices within the organizations purchasing and utilizing GIS software (Pinto and Onsrud 1995; Harvey and Chrisman 1998; Tulloch 1999; Harvey 2000; Martin 2000; Sieber 2000).

HOW GIS SHAPES SOCIETY

Those examining the societal implications of GIS have undertaken research seeking to evaluate a number of the critiques of GIS raised by social theorists: limits to GIS representations of the world; limits in access to and the appropriateness of GIS technologies; legal and ethical implications of GIS use; and the applicability of GIS for redressing social and geographical inequalities.

Those examining the limits of GIS representations of the world have taken seriously the criticism that GIS, as we know it, undergoes a process of representational stabilization – a process whereby the world becomes represented in a particular way. First, GIS software represents space as a Cartesian coordinate system, following Newton in representing space as an independent grid within which social processes are located, rather than Einstein or Leibnitz's arguments that space is relational (Harvey 1990; Castree 2002). Rundstrom (1995), for example, shows that American Indian conceptions of space are inconsistent with those used in GIS, arguing that this makes GIS inappropriate for representing Indian life-worlds. More generally, such criticisms contrast the instrumental rationality of GIS with the communicative rationality of life-worlds and conclude that GIS has difficulty capturing the latter. Others have argued that GIS, reflecting its origins in cartography, represents space usually as a set of attributes attached to places, and rarely as a relational mapping of the interdependencies between those places (Sheppard 1993). Second, GIS representations emphasize institutional databases as the primary source of reliable information about the world (qualified by any metadata describing limitations of databases). Jon Goss (1995) examines how the classifications of lifestyles and neighbourhoods developed by geo-demographic marketing firms, based on GIS analysis of census data, may shape life-worlds and the places in which they are pursued (see also Curry 1998; Clarke 2000). Paul Robbins (Robbins and Maddock 2000; Robbins 2003) and Wolfgang Hoeschele (2000) show how the categories developed to classify GIS and remote sensing information shape land use practices in South Asia. Trevor Harris and others (1995) experiment with incorporating sketch maps made by local farmers in South Africa into a conventional GIS in order to determine how the capabilities of GIS can be extended to incorporate life-world-based information. These sketch maps represent black and white African farmers' views of the landscape, reflecting their local narratives about land alienation under apartheid.

Research examining limitations in access to and the appropriateness of GIS has been framed by the

observation that GIS was initially developed for large social organizations (the military and other state agencies, universities, corporations), not for ordinary people living everyday lives. In addition, GIS software has been expensive, until recently, and requires extensive training, creating access barriers for ordinary people. While GIS use by such agencies affects everyday life, in positive and negative ways, to what extent can or should GIS be used by ordinary people to enhance their livelihoods? In response to this challenge, a productive research program has emerged around the theme of public participation GIS (PPGIS) (Obermeyer 1998a).

In seeking to overcome the limitations of conventional GIS and support its pluralistic use, PPGIS research has principally engaged with four broad questions. The first is whether GIS can also be used by grassroots organizations to empower themselves within society. This question has led to an extraordinary efflorescence of research in local communities around the world (Craig, Harris, and Weiner 2002a). Using a variety of strategies for enhancing participatory decision making, integrating local knowledge with GIS databases, and training local residents to use geographic technologies and methods, this research has demonstrated that GIS can be used as a part of participatory decision making. The second is what kinds of strategies can reduce access barriers. While a variety of strategies have been applied to extend the availability of GIS to community organizations, our understanding of the relative merits of different strategies remains speculative (Leitner and others 2000).

The third question is what the implications are for grassroots organizations once they start to use GIS. Research on this topic entails a variety of sub-themes: what grassroots organizations do with GIS; whether GIS empowers grassroots organizations to ''jump scale'' and influence larger-scale institutions; and whether use of GIS by community organizations enhances their ability to represent and reflect the views of the community they purport to represent. Research addressing these questions remains in its early stages (Craig, Harris, and Weiner 2002b), but the studies that have been completed do not suggest that PPGIS is dramatically empowering grassroots communities. For example, research in Minneapolis and Milwaukee shows that neighbourhood organizations often use GIS for monitoring and regulating the territory they represent and to present that territory in the best possible light in negotiations with larger-scale institutions. Such actions conform more to the instrumental rationality of the state than to the communicative rationality of everyday life (Habermas 1984, 1985). While seeking to empower themselves through such actions, neighbourhood organizations may well find themselves conforming to, rather than challenging, the policy priorities of the local state within which they are located (Elwood and Leitner 1998, 2003).

The fourth question is whether current GIS software is appropriate for such purposes. This was a high-priority theme for the GIS and society research agenda at the 1995 NCGIA meeting, but little progress has been reported (Sheppard and others 1999; the topic receives barely a mention in Craig and others 2002a).

Research into legal issues has focused on legal remedies for undesirable social implications stemming from the diffusion of GIS and georeferenced databases (Cho 1995). Prominent themes include violations of privacy resulting from the capability to map individual actors and events (Onsrud, Johnson, and Lopez 1994) and from enhanced surveillance capabilities that GIS use gives organizations (Clarke 2000); the question of legal responsibility for demonstrably inappropriate and harmful uses of GIS (Stewart, Cho, and Clark 1997); the barriers posed by charging the public for the use of spatial data (Onsrud 1998); and the legal implications of the international transfer of GIS standards (Curry 1996).

Several of these legal problems make visible the importance of ethical issues in any discussion of the impact of GIS on society. Research in this area reflects legal issues of privacy and responsibility (Pickles 1991; Onsrud 1995, 1997), but it also raises broader implications about the ethics of science and the need for an ethical code of conduct for GIS professionals (Crampton 1995; Obermeyer 1998b) – recently formalized in the United States by the Urban and Regional Information Systems Association (URISA) as the GIS Certification Institute (2005). Ethics and GIS remains an under-researched area, one that has generated more heat than light and has often failed to draw on the wealth of interdisciplinary research on ethics and justice. Yet there may be quite fundamental ethical questions associated with GIS. Michael Curry (1998), for example, argues not only that are there significant ethical issues revolving around GIS use but also that a close examination of GIS reveals conventional models of ethical behaviour to be problematic.

The use of GIS to redress social inequalities can be exemplified by GIS-based analyses of environmental justice (cf. Nyerges and McMaster 1997). The environmental justice movement in the United States was catalysed by a spatial correlation analysis establishing the co-location of ''toxic release inventory'' sites in counties with large non-white populations, providing an example of how geographical analysis can empower social movements (Bullard 1993). Using GIS as a tool for spatial analysis, including Monte Carlo simulations for distribution-free spatial statistical analysis, has brought enhanced rigour to this area of empirical research, where different studies have suggested very different conclusions about the nature and even the existence of environmental racism or inequity. Considerable complexities in the relationship between exposure, social characteristics,

and location have been revealed and measures for determining their significance explored (cf. McMaster, Leitner, and Sheppard 1997; Scott and Cutter 1997; Scott and others 1997; McMaster and others 1999). GIS can thus powerfully expose some aspects of environmental inequity and possibly contribute to the effectiveness of the environmental justice movement.

Yet Stuart Aitken's suggestion (2002, 364) that "the GIS community enabled a strong public . . . and, at the local level, . . . spatial analysis empowered community decision-making" is, as yet, overly optimistic. There is little evidence that the environmental justice movement is employing GIS. Indeed, a key question for legal cases brought by the environmental justice movement – whether toxic facilities or minority communities came first – cannot be answered with current GIS databases. It requires more conventional historical geographic research (Pulido 2000). It is possible to imagine using GIS to empower and mobilize disadvantaged communities around environmental justice concerns. A two-year study in Minneapolis's poorest and most ethnically diverse area, Phillips Neighborhood, demonstrated how GIS can be used to create a neighbourhood environmental inventory to visualize neighbourhood environmental issues in a way that reflects local knowledge and priorities (Kurtz and others 2001). Yet a predominant conclusion arising from this demonstration project is the enormous difficulty of undertaking university–community research that catalyses community action (Leitner and others 2000). In short, much of the application of GIS to addressing social inequality still employs GIS, as we know it, in conventional ways.

The Present: Critical GIS

Recently, there has been a substantial shift in the discursive frame within which research transcending the GIS social theory divide is set, from "GIS and society" to "critical GIS" (Schuurman 1999). Like the term science, the adjective "critical" has a variety of resonances that reflect the contexts in which it is used, leading to intermittent discussions about what the term means on the critical GIS discussion list (CriticalGIS@geography.ohio-state.edu). For some, to be critical simply means not accepting anything at face value. This sense is broadly inclusive. Indeed, to take a favourite *bête noire* of critical geographers, positivism places criticism at the centre of its attempts to separate science from religion and metaphysics. "Critical" also carries the discursively useful connotation of critical importance: in this meaning, critical GIS can be framed as vital to the future of GIS. In the context of human geography, however, "critical" has a much more precise meaning, reflecting the current influence of social theory within Anglo-American geography. In this context, the use of "critical" positions GIS research as a branch of the more general research program of critical geography. To see what this might mean, it is important to clarify the intellectual origins of critical geography.

CRITICAL GEOGRAPHY AND GIS

In human geography, the meaning of critical geography reflects its emergence out of radical geography during the 1980s. The term "critical theory" was coined in the 1930s by the Frankfurt School of social theorists (including Horkheimer, Adorno, Marcuse, and, more recently, Habermas and Offe) to describe their variant of Marxism. They saw themselves as departing substantially from Marx while maintaining his concern for social and political structures and human emancipation. Rejecting both capitalism and "scientific" socialism (of the kind attempted under Communism) as failing on these grounds, they sought a third way.

The Frankfurt School pays close attention to the impact on society of economic and political rationality. Money is the basis of economic rationality, and power is the currency of political rationality. The two are closely related, and both are forms of instrumental rationality, that is, actions taken to achieve a well-defined goal. The Frankfurt School saw technology as vital to pursuing instrumental goals, and Horkheimer and Adorno wrote at length on the relationship between technology and society. They argued that economic and political rationality are leading to a commodification of society and culture; an expansion of the division of labour and bureaucracy; a rationalization of social life; and a subordination of local initiative. Habermas argues that an alternative form of rationality, communicative rationality, characterizes how people communicate on an everyday basis as they seek to achieve mutual understanding. He sees the instrumental rationality of economic and political systems as increasingly penetrating everyday life, undermining communicative rationality, and resulting in a colonization of the life-world by the system (Habermas 1984, 1985). The Frankfurt School argued that a major consequence of these developments, whether under capitalism or scientific socialism, was a diminution of class identity and consciousness. They saw their project as directed toward exposing the resulting domination of the working class, as a means to promote emancipatory alternatives.

The Frankfurt School has not received a great deal of attention from human geography's critical social theorists (with the exception of Walter Benjamin), even though they share the Frankfurt School's project of departing from a more rigid Marxism while maintaining a focus on emancipation and empowerment of the disadvantaged. In their editorial introducing the new e-journal of critical geography, *ACME,* Lawrence Moss,

Pamela Berg, and Caroline Desbiens define critical and radical geography as,

> for example, anarchist, anti-racist, environmentalist, feminist, Marxist, postcolonial, poststructuralist, queer, situationist, and socialist. By critical thinking and radical analysis we mean that the work is part of the praxis of social and political change aimed at challenging, dismantling, and transforming prevalent relations, systems, and structures of capitalist exploitation, oppression, imperialism, neo-liberalism, national aggression, and environmental destruction. (2001, 3)

Thus, as radical social theory has taken new turns in Europe and North America, ''critical'' has become an umbrella term to represent this spectrum. Indeed, Castree (2000) argues that the shift from ''radical'' to ''critical'' in fact marks an undesirable institutionalization, taming, and even cooptation of radical geography.

Within geography, even as new generations of critical social theorists took great pains to differentiate themselves from such Marxist geographers as David Harvey, there was a shared rejection of mainstream science and its technologies and practices (Sheppard 1995a). Figures 1 and 2 visualize the relationship between the competing epistemologies under debate in human geography. Figure 1 depicts three contrasting ontologies (cf. Bhaskar 1975) through which geographers attempt to make sense of the world: logical empiricism/positivism (in which observation is the key to explaining the world); structuralism (in which the world is explained as the consequence of often unobservable underlying structural mechanisms); and idealism/hermeneutics (in which our world is a realization of the idealizations and interpretations that humans impose on it). During the 1970s philosophical debates in geography, these poles came to be associated respectively with spatial science, radical geography, and humanist geography. Each pole depicts an unsustainable ideal type. For example, logical empiricist research requires that data be interpreted (idealism) and that correlations be explained by underlying mechanisms (structuralism). Structuralism insists that observation cannot reveal vital structural mechanisms but still seeks to account for the world we experience.

Figure 2 locates the various philosophical approaches that human geographers have experimented with since the 1960s with respect to these three poles.[4] Critical geography sees itself as occupying the right-hand side of this diagram, through its embrace of both structural and post-structural approaches. The location of GIS close to the empiricist pole visualizes the opposition between critical human geography and GIS that lay behind the debates of the 1980s with which this article began. Such critiques shared Frankfurt School concerns about how science and technology (in this case, spatial science and GIS) are tools of instrumentalism and oppression in modern society.

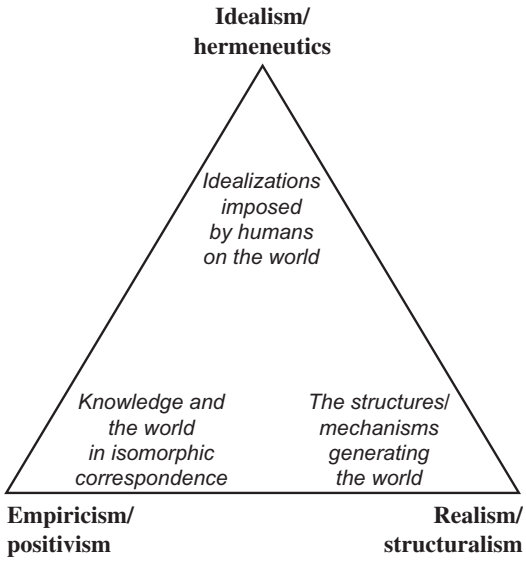

Figure 1. Three complementary ontologies.

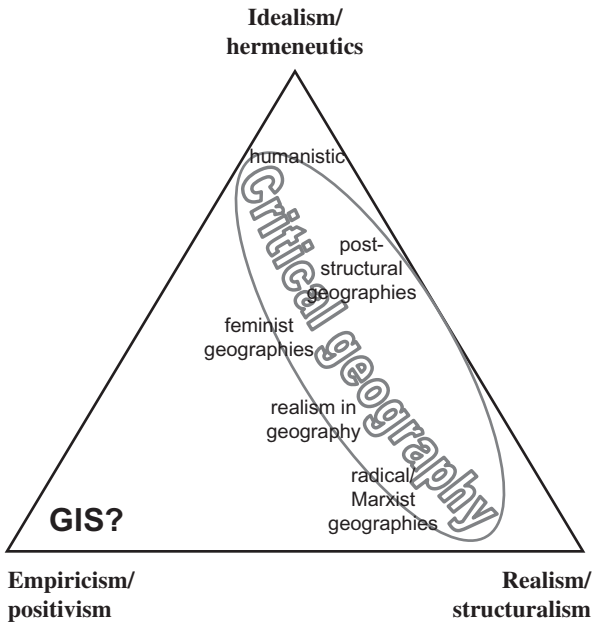

Figure 2. Representing critical geography.

Yet the question mark indicates that this placement should not be taken at face value. When critical geographers locate GIS here, they reinforce an opposition between GIS and critical theory that can seemingly only be resolved by deconstructing GIS and resolving the dialectical tension between GIS and social theory in favour of critical human geography. In this view, the shared propositions of critical geography are identical to those of critical GIS. Tempting as this may be for those who, like me, position themselves as critical geographers, such an interpretation is problematic. As I indicate below, GIS need have no special relationship to logical

Table 1. Papers read at critical GIS special sessions at 2002 AAG meeting, Los Angeles, CA

Brian Klinkenberg	Neighborhoods through Space and Time
Bill Macmillan	Technology for Democracy: The Use of GIS in the Defence of Public Interest in Political Redistricting
Nadine Schuurman	Preserving Standardization AND Multiple Ontologies in Data-Sharing Environments
Renee Sieber	Rewiring GIS
Peter Fisher, Tao Cheng	Double Fuzziness: Fuzziness in Fuzzy Assignment of Duneness
Kevin St. Martin	Relying on GIS: Overcoming the Dissonant "Landscapes" of Fisheries Management and Fishing Communities
Thomas Whitfield	Same Code, Different Places: The Relationship Between GIS and Cultural Geography in Landscape Representation
Robert Macfarlane, Rachel Pain, Keith Turner, Brian Williams, Sally Gill	Qualifying GIS: Streetlighting, Victimization and Fear of Crime
Mei-Po Kwan	Constructing Cartographic Narratives of the Geographies of Everyday Life Using 3D GIS
Claire Pavlik	Mixing Methodologies: Using GIS to Frame Qualitative Research
Marianna Pavlovskaya	Using Mixed Methodologies to Understand Multiple Economies: A Case Study of Three Neighborhoods in New York City
Mordechai Haklay, Carolyn Harrison	Public Attitudes to the Potential of Public Participation GIS in UK Local Planning: The Findings of Two Workshops
Robert B. McMaster	PPGI Science vs. PPGI Systems
Trevor Harris, Daniel Weiner	Perspectives on Public Participation Geographic Information Systems

empiricism, implying that the shared propositions of critical GIS may exceed those of critical theory.

TOWARD A CRITICAL GIS

Despite superficial similarities, GIS should not be reduced to critical human geography, for two reasons. First, the opposition between GIS and critical theory suggested by Figure 2 is a misleading caricature of a much more nuanced relationship. Second, critical GIS attracts a variety of researchers who do not align themselves closely with critical human geography.

I have argued at length elsewhere that GIS is not inherently positivist, as part of a broader argument that critical human geographers need to be wary of their tendency to represent much of quantitative geography as positivist and therefore objectionable (Sheppard 2001c). To summarize, to depict GIS as a handmaiden of positivism is to suggest that it is quantitative, logico-deductive, and empiricist, none of which are necessary properties of GIS. Work within PPGIS shows that many kinds of qualitative information and situated perspectives (images, narratives, sketch maps) can be incorporated within a conventional GIS. This information sits side by side with conventional GIS data sets and analytical tools, without being incorporated into their logical structure. For example, Stephen Matthews, James Detwiler, and Linda Burton (2005) show how ethnographic narratives can be given new meaning by locating them in geographic space with the help of GIS. The resulting GIS may be used prescriptively by, say, neighbourhood residents seeking to change their corner of the world. Together, these modifications undermine all three of the supposedly positivist features of GIS. Mei-Po Kwan (2002) similarly argues that, notwithstanding the tendency of GIS to represent the world via "the god-trick of seeing everything from nowhere" (Haraway 1991, 189) and other difficulties in capturing key elements of feminist theory, GIS can be tweaked in ways that allow it to represent situated and embodied perspectives on the world and to empower women. Nadine Schuurman (2001) highlights the presence also of considerable epistemological reflection in mainstream GIS, particularly experiential realism (cf. Couclelis 1999).

Second, the topic of critical GIS is attracting a wide variety of scholars who do not approach it from a critical theory background. This was particularly evident at the 2002 Association of American Geographers meeting (see Table 1). For these participants, critical GIS provides a vehicle to explore a range of issues, from those central to the GIS and society research agenda (such as PPGIS), to technical papers seeking to address representational limitations of GIS, to ways of combining GIS with qualitative methods. This is clearly invoking in part the broader sense of "critical" discussed earlier. Yet such diversity was less evident by 2004, albeit in sessions more narrowly focused on qualitative methods and GIS (see Table 2). Interrogating such openings, and closures, is necessary to reimagine both GIS and critical theory and to open up intellectual space for rethinking the future of critical GIS.

Table 2. Papers presented in qualitative geography and GIS sessions at 2004 AAG meeting, Philadelphia, PA

Sarah Elwood	GIS, Spatial Stories, and Negotiating Multiple Visions of Neighborhoood Revitalization
Marie Cieri	Qualitative Research and GIS: Re-representing Space and Place from African-American Perspectives
Rina Ghose	Investigating Public Participation GIS through Qualitative Research Methods
Tanuka Bhowmick	Ethnography, Geographical Information Systems (GIS) and Visualization
Talia M. McCray, Nicole Brais	Modeling Travel Behavior of Disadvantaged Women in a Qualitative/GIS Environment to Educate Transportation Policy Makers in Quebec City
Guoxiang Ding, Mei-Po Kwan	3D-VQGIS:3D Visualization and Qualitative Analysis of GeoSpatial Data
Tae Han Kim	Digital Contrails: Visualizing Movement through Urban Data Clouds
Elizabeth K. Burns	Urban Patterns in Water Operations: A Qualitative Approach using Spatial Technologies in Phoenix, Arizona
Peter A.K. Kyem	Of Intractable Conflicts and Participatory GIS Applications: The Search for Consensus amidst Competing Claims and Institutional Demands
Dalia Varanka	Snapshots in Critical Cartography: History, Theory, and Evidence
Renee Sieber	Defining PPGIScience
Barbara Poore	Actor-Network Theory and Critical GIS
Nadine Schuurman	Whither Critical GIScience?

The Future: Practising Critical GIS

I propose the following overarching precept for practising critical GIS: critical GIS research should be *relentlessly reflexive*.[5] By this I mean that its practitioners should restlessly seek to identify the presuppositions that emerge as it takes form as a research program, and thereby shape its trajectory, subjecting these to critical reflexive examination. Reflexivity, in this sense, means not only asking how to progress along emergent research trajectories but also asking how the shared beliefs underlying those trajectories themselves foreclose other paths of research. Obviously, there is a need to retain a dialectical tension between the reflexivity called for here and concrete research – that is, between external, lateral assessments of current trajectories and refinements along those trajectories. Yet practising critical GIS also means never standing still, but identifying and problematizing shared presuppositions. To exemplify the nature and importance of the kind of critical reflection urged here, I briefly discuss three themes: technology; the geography of knowledge production; and science and politics.

TECHNOLOGY

In discussing the role of technology within the performance of science, Andrew Pickering argues that scientists encounter a ''mangle of practice'' (Pickering 1995), by which he means that science is the result of a dialectics of resistance and accommodation between human and non-human agency. Humans practising science experience resistance to what they wish to achieve, because technology does not work as they would like. Technologies thereby exercise non-human agency, shaping not only everyday scientific practice but also longer-term norms – as scientists internalize technological difficulties by limiting their research questions to what is technologically straightforward. Of course, periodically human agency is exercised over technology as a major effort is made to redesign it to overcome perceived limitations. Indeed, Pickering, unlike Bruno Latour (1993), argues that the dialectic is asymmetric, since intentional, forward-looking human agency has the upper hand. Yet at all times a ''dance of agency'' is under way, with human and non-human agents engaged in a ''reciprocal tuning'' of each other's conditions of possibility.

Anyone familiar with GIS software can attest to the everyday fine tuning, fiddling, and frustrations of getting GIS to work – particularly as we seek to stretch its capabilities, but also for mainstream applications. As a result, GIScience accommodates itself to the constraints posed by technology; GIS researchers limit what they do to what the software permits or can be tweaked to permit. Critical GIS recognizes the socially constructed nature of GIS as a technology, but there has been limited critical reflection on what GIS technology is. By and large, GIS is still taken to mean mainstream GIS software. This has been a necessary and useful presumption, allowing substantial progress in certain directions, but at the cost of constraining both the practice and the scope of critical GIS. To date, critical GIS has found itself dancing more to the tune of GIS-as-we-know-it than was anticipated, rather than remaking or rethinking the technology.

GIS AND PPGIS

The PPGIS research program exemplifies the asymmetry of this dialectic of resistance and accommodation in

critical GIS.[6] Considerable progress has been made in creating contexts in which GIS software can become part of participatory decision making and in supplementing mainstream software with multimedia plug-ins and sketch-mapping facilities that permit the incorporation of non-instrumental local knowledge with mainstream GIS analyses. We are beginning to develop an understanding of the pros and cons of different schemes for making GIS software available to grassroots neighbourhood and community organizations, in different geographic contexts, and have already learned a great deal about what such organizations do with GIS software and the ways in which they are (or are not) empowered through its use. Yet some of the driving questions behind PPGIS remain difficult to answer: Is its use for participatory decision making and by community organizations making such organizations more instrumental in outlook and less in touch with the communicative rationality of everyday life? Is the spread of GIS creating new tensions, both within grassroots organizations and between the organization and those it purports to represent, as a result of an emergent digital divide between those who are knowledgeable about (and perhaps accommodated to) GIS and those who are not?

The difficulties in making PPGIS exemplary of a strong associative democracy, which gives people a voice as equal stakeholders in society, often lie outside the domain of technology or of grassroots groups (cf. Craig and others 2002b) – in the realm of the social structures, identities, and norms that shape inequality and conflict, at scales ranging from the household to the globe. Yet PPGIS that remains focused on off-the-shelf GIS software is always in danger of accommodating its research trajectory to that software. Of course, GIS software is continually evolving, as layer-based systems are supplemented by object-oriented approaches, software supporting collective decision making is developed, and sketch-map supplements to mainstream software come onto the market. Each of these has the potential to enhance the capability of off-the-shelf software for PPGIS, although the accessibility of such innovations to grassroots organizations remains in question and their impact on democratizing decision making requires research.

Despite periodic discussions and visionary statements (Openshaw 1997), alternative GIS software written explicitly with participatory decision making in mind, as opposed to software extending current GIS capabilities, remains to be written. The following assessment remains pertinent:

> It is important to develop a parallel area of research into new types of GIS technologies, perhaps more reflective of the flexibility and communicative logic of Java and the Web than the complex logic of expert programs over which users have little influence. To be effective in designing geographical information systems that are appropriate for all areas of society, such developments should combine the practical experiences of new users struggling with currently dominant GISs; the expertise of programmers, graphic artists and communications specialists; and the experience and expertise of individuals skilled in the study of GIS and society. (Sheppard and others 1999, 816)

Of course, Java and Web-based software already exist, but they are rarely part of our shared presuppositions about what constitutes GIS. The Internet, for example, is a geographic information system. This arena of cyberspace is broadly accessible and user friendly; communicative rather than instrumental in its logic; accepting of all kinds of information, from mathematics to art; chock full of geographic information (statistics, photos, Web cams, narratives); and constituted out of the situated knowledge, opinions, and information of participants representing a wide range of social and geographic contexts. The Wikipedia (http://en.wikipedia.org), an on-line encyclopaedia to which anyone can post an entry, illustrates the richness of information that is possible under such communicative logics. Of course, users of the Internet also often subconsciously accommodate to its socio-technological and cognitive limitations, including inequalities in access; non-transparency of information sources; and privacy, censorship, and surveillance practised by large public- and private-sector users. Yet the possibility of using this geographic information system, rather than off-the-shelf GIS software, as the starting point for practicing PPGIS remains largely unexplored. Richard Kingston (2002) describes a fascinating Internet-based PPGIS community planning experiment, but GIS maps remain the primary source of information, and ''fuzzy'' situated knowledge remains to be incorporated.

GIS AND GITs

While off-the-shelf GIS software has shaped GIS research and practice, the very different social trajectory of geographic information technologies outside the academy raises the question of whether GIS software should be the focus of critical GIS. Mobile computing has made sophisticated digital information technologies widely available and increasingly geographic. These include GPS, auto navigation systems, cell phones, geographically aware PDAs (equipped with cell phones, GPS, or Web cams), CCTVs, and microprocessors embedded into credit and ID cards, pets, and certain individuals (e.g., Alzheimer patients). By contrast to mainstream GIS software, these geographic information technologies (GITs) are often cheap, portable, and user friendly. They are also changing the nature and importance of geographic information. It is common to begin a cell-phone conversation by determining where the callers are located – precisely

because of the mobility of the technology. Location-based services, the concept whereby people receive advertisements for nearby businesses on their cell phones, is a fast-growing by-product of mobile geographic information technologies that, again, is making location a vital attribute of information (cf. Goodchild 2000). Our focus on digital technology can also lead us to overlook too easily the importance of non-digital geographic information systems. Every animal's brain is a sophisticated geographic information technology finely adapted to that individual's situated life-world.

In light of this fast-changing plethora of GITs, the critical GIS research program should reassess the presupposition, inherited from GIS's roots in cartography, about what GIS is. Of course, there already exists an active research agenda on the geography of the information society, and many of these questions are under investigation (cf. Hepworth 1989; Castells 1996; Curry 1998, 2002; Graham 1998; Leinbach and Brunn 2000; Sheppard 2001b; Aoyama and Sheppard 2003). Practitioners of critical GIS should communicate more actively with this body of research, with its parallel focus on the relationship between GITs and society.

GEOGRAPHY AND KNOWLEDGE PRODUCTION

Practitioners of critical GIS also often implicitly share presuppositions about the geography of the knowledge they are involved in creating. Despite the best intentions, these presuppositions can reinforce the very asymmetries in the geography of knowledge production that critical GIS seeks to overcome. I highlight two asymmetries in the geography of knowledge production here: between universities and communities, and between the global North and the global South.

Community–University Collaboration

Off-the-shelf GIS software requires significant expertise to operate it, including not only familiarity with the software but also an understanding of the principles of geography. Thus technical and geographic expertise is agreed to be central to practising critical GIS, notwithstanding the desire of its practitioners to empower individuals in their everyday lives. Universities are places where knowledge and expertise is created, whereas communities are seen as places that are dependent on that expertise. This results in tensions in university–community partnerships, often placing university partners practising critical GIS in frustrating situations that contradict their inclinations or objectives. On the one hand, they find community members suspicious of their expertise and their outsider status, notwithstanding what they believe to be their best intentions. On the other hand, if successful in gaining the trust of community members, they are often discomfited by the willingness of community members to then defer to university expertise rather than becoming full collaborative partners (Leitner and others 2002).

As part of their effort to undertake activist scholarship, practitioners of critical GIS must problematize the presupposition that good intentions can overcome the gown/town divide, a common misapprehension of campus-based activism more generally. The belief that geographic expertise is the exclusive province of trained geographers, and that GIS expertise requires training in software developed for research, planning, and commerce, reproduces universities as the source and communities as recipients of knowledge. In fact, one of the distinguishing features of geographic knowledge production and understanding is that it is also central to everyday life, undermining the convention that knowledge production is, or should be, bounded within academic lifeworlds (cf. Leitner and Sheppard 2003).

First-World Technologies, First-World Knowledge

We have learned from activist research involving community–university partnerships that critical GIS research faces considerable problems when carried out in different geographic contexts from those in which knowledge and expertise, and GIS, are produced. This complexity is redoubled for research carried out in the global South, which I define for present purposes as places (at scales from the neighbourhood to the supranational) where poverty and social and environmental degradation remain persistent features of everyday life (Sheppard and Nagar 2004). Postcolonial scholarship has effectively highlighted the presumptions that tend to reinforce a hierarchy in knowledge production between the global North and the global South. These include viewing knowledge produced in the global South as primitive or uninformed, viewing history as a universal sequence of stages through which progress occurs, viewing geographical differences as deviations from an ideal norm provided by the First World, and characterizing any such deviations as arrested or distorted development (cf. Massey, 1999; Chakrabarty, 2000). Postcolonialism has also shown how efforts to overcome such hierarchies are plagued by a paradox: to have much impact outside the global South, alternative ways of conceptualizing must be produced by people trained in First World ways of thinking and capable of writing in the sophisticated and ethereal academic language of First World scholarship.

Critical GIS scholarship is being carried out in the global South, and it can be of considerable relevance to local conditions of life there (Harris and others 1995; Jordan 2002; Kyem 2002). There also exists off-the-shelf GIS software developed particularly with local conditions in mind, such as IDRISI (cf. Yapa, 1991). Yet off-the-shelf GIS software is by and large the product of First World academic, government, and commercial efforts. It is expensive to purchase and maintain and difficult to

learn, and we cannot presume that it is appropriate for global South communities. Critical GIS research in such communities must subject academic knowledge from the global North to the same constructive but critical scrutiny as knowledge produced in the global South; must entail an intimate familiarity with the complexities, conflicts, and contradictions shaping the communities where research is carried out; should value and draw on the full spectrum of knowledge and expertise in those communities; and should adopt a broad conception of geographic information systems and technologies, one that does not implicitly prioritize mainstream GIS and First World instrumental approaches to social change. In short, breaking down pre-existing hierarchies of knowledge production between elite and marginalized spaces will require a forum for critical but non-hierarchical debate, in which the most cherished beliefs of critical GIS researchers are also subjected to vigorous criticism from all potential stakeholders. The same is true for critical geography, and for science.

SCIENCE, AND POLITICS

The question of science has underlain many discussions of critical GIS. Recall that social theoretic critics of GIS in human geography were suspicious of the association of GIS with logical empiricist and positivist definitions of science. Recall also that such concerns re-emerged when GIS was rechristened Geographic Information Science (henceforth GISci) (Goodchild 1992). Proponents of GISci sought to broaden what is meant by ''science'' (Wright and others 1997), and Bob McMaster has recently speculated on the possibility of PPGISci (McMaster 2002). Yet too often such discussions presuppose a clear division between a universal truth-revealing science and other epistemologies; between truth and error, or knowledge and belief. In this view, science entails a foolproof method to arrive at an intersubjective explanation or understanding of the world.

Practising critical GIS requires deconstructing and moving beyond this image of science. First, contemporary philosophy of science, as well as science studies, recognizes that this vision of science is not attainable. Second, when applied in geography it mistakenly stereotypes GIS, and quantitative geography more generally, as positivist science (Sheppard 2001c; Kwan 2002; Schuurman 2002). Third, it creates a continual source of tension and division within the epistemologically broad community of scholars pursuing a critical GIS research program, undermining our ability to learn from one another (Schuurman and Pratt 2002). By contrast, the epistemological breadth and common interests found within critical GIS create the possibility of adopting a more inclusive vision of science – geographic or otherwise. In this vision, rigorous scientific scholarship is not about the one best method and universal truth. Rather, it is about an ongoing engagement and debate between the full range of ''scientific'' methods, each capable of producing reliable but situated understandings of the world, and involving the full range of potential stakeholders in seeking to understand and improve the world – from trained geographers to regular people practising neighbourhood science (cf. Heiman 1997). Different understandings then imply different politics and visions for social change that must also be debated, in a forum governed by strong, associative democratic principles.

In *The Fate of Knowledge*, Helen Longino (2002) presents a vision for this kind of scientific knowledge production that seeks to transcend the dualism currently separating philosophy of science and science studies. She argues that science studies provides compelling accounts of how scientific knowledge is socially constructed, but does so at the expense of being unable or unwilling to make normative judgements about the truths thus created. In this view, social studies accounts are, somewhat paradoxically, resolutely empirical and tend toward a relativist stance on explanation. By contrast, philosophers of science make normative statements, to separate science and knowledge from opinion and belief, but limit themselves to cognitive/rational principles (such as those of coherence or correspondence in logical empiricism) that neglect the obviously social nature of knowledge production. Longino seeks to catalyse knowledge production that is simultaneously normative and non-relativist.

In her analysis, a ''plurality of adequate and epistemically acceptable explanations or theories can be generated by a variety of different factors in any situation of inquiry'' (Longino 2002, 184). This amounts to a plurality of local epistemologies, each pursuing its own trajectory of knowledge production, in part by excluding others, with none having a corner on truth and objectivity – not even science. The current predominance of certain monistic ''scientific'' accounts of the world, she argues, too often is a result of excluding competing epistemologies and differently situated practitioners from scientific debate rather than a result of rigorous external evaluation.

In order to reach adequate understandings that could be normatively judged as knowledge, Longino envisions a social approach to science quite different from current practices. In this view, monist accounts should only be finally accepted as qualifying as knowledge/science after they have been opened up to criticism from the full range of alternative local epistemologies, under conditions of open-minded and even-handed critical engagement (see Table 3). The principle of tempered equality is particularly important, echoing the attempts of feminist philosophers of science to radically diversify

Table 3. Longino's conditions for strong knowledge production

Venues:	Publicly recognized forums for criticisms of evidence, methods, assumptions and reasoning; criticism to be given the same weight as original research.
Uptake:	Criticism must be taken seriously, and theories adjusted in the face of adequate criticism.
Public standards:	There must be publicly recognized standards for evaluating knowledge claims and the relevance of a criticism to a particular knowledge claim, to which criticisms must refer in order to obtain a hearing.
Tempered equality:	Communities must be characterized by equality of intellectual authority. The social position or power of a community should not determine which perspectives are taken seriously. Participation is tempered by the side-condition that full recognition of participants requires that they conform to the responsibilities and standards discussed above.

Source: Leitner and Sheppard (2003, 528), after Longino (2002).

the community of scientists and thereby deconstruct and decentre the knowledge claims that emanate from a largely male, white, and First World scientific community (Harding 1991).[7]

In this view, the goal of science need not be an agreed truth about the world but can be a restless target – a ceaseless debate between different local epistemologies that nevertheless provides more reliable and justifiable knowledge of the world than any artificial resolution into a monist viewpoint. Such debates between situated perspectives are inevitably also political: not only are data always theory laden, but our theories are laden with culture, politics, and opinion. Different theories are articulated on the basis of differing assumptions and presumptions about how the world works and how it could work better. In this view, science and politics are not opposed but go hand in hand. A strongly democratic forum of the kind envisioned by Longino provides the possibility for recognizing such links and engaging in debates that have the rigour of science and the openness of a politics of difference (Young 1990). Critical GIS has gained traction by challenging mainstream GIS to just this kind of debate. Yet complacency accompanying the success of critical GIS runs the risk of foreclosing further debate and innovation.

Reproducing a Critical GIS

The research program that began to prosper as ''GIS and society'' succeeded in establishing collaboration between researchers with initially quite distinct local epistemologies around the common theme of the relationship between GIS and society. While GIS and society began as a ''trading zone'' or ''boundary object,'' a realm with the pliability to enable very different perspectives to cooperate (cf. Star 1989; Galison 1997), it has become a research program with its own trajectory, commonalities, and exclusions. Trajectories are contingent: some themes took off, particularly those of PPGIS and the representational implications of GIS, while others languished, such as feminist GIS, which only now is gaining attention (Kwan 2002; Schuurman and Pratt 2002). The shift to critical GIS entailed reformulating the research program around a common theoretical approach, critical theory, rather than a common theme. This deepened its intellectual foundation and connected it effectively to the dynamic field of critical human geography.

Yet the very shared presuppositions that solidify any research program freeze critique and discourage reflexivity. For critical GIS to maintain its critical edge, it will be necessary for its practitioners to challenge their own emergent shared presuppositions: about the relationship between critical theory and GIS; about what GIS is; about the geography of knowledge production and consumption; and about the nature of GISci. Critical GIS does have the potential to deconstruct current presuppositions about critical theory and science by making space for all kinds of local epistemologies, developed within the variety of communities concerned about geographic information technologies and society, in and beyond the academy. Yet critical scholarly inquiry must remain self-reflexive and willing to engage with difference within and outside its own critical scholarly community, opening itself up to the kind of external evaluation envisioned by Longino. Self-styled critical geographers interested in GIS must be willing, therefore, to offer our theoretical, ideological, and political concerns and desires up for public debate, recognizing that our most cherished taken-for-granted presuppositions may not persuade others and may have to be withdrawn or rethought.

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Notes

1. I use the spelling "programme" to distinguish Lakatos's conception from that of Hacking.
2. This section draws from Sheppard (2001a).
3. Simultaneously, many mathematical geographers were sceptical of GIS because of the very limited kinds of spatial analysis incorporated in the software.
4. Shifting trajectories of knowledge production with respect to these ontological poles are not shown here, such as feminist geography's evolution from empirical, to radical, and then to post-structural feminism.
5. When Nadine Schuurman (1999) coined the term "critical GIS," she also sought to challenge the presupposition that GIS can be absorbed into critical geography. The influence and resonance of "critical" in contemporary Anglo-American human geography, however, creates a context in which the kind of reflexiveness that she and I call for remains hard to achieve.
6. I select PPGIS for attention here not because the dialectic is particularly problematic for this area of critical GIS research but simply because this is an active and well-defined sub-field of critical GIS with a track record detailed enough to permit some assessment.
7. Longino's principles are reminiscent of Habermas's ideal speech community, but with an important difference. Habermas envisions that communicative action within such a community will eventually result in consensus (a monist understanding), but Longino argues that this kind of strong consensus is unnecessary: an ongoing debate between different situated understandings, never resulting in consensus, is equally insightful. It is also reminiscent of, but less reductionist than, attempts by Donna Haraway and Sandra Harding to articulate "strong" objectivity as the result of incorporating a diversified set of standpoints or situated perspectives into science.

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