
Negotiating Knowledge Production: The Everyday Inclusions, Exclusions, and Contradictions of Participatory GIS Research*

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Although participatory approaches to geographic information system (GIS) use have significantly altered the technological and social practices of GIS-based research and decision making, they have received relatively little attention within discussions of participatory research. This paper examines how participation and representation are negotiated in participatory GIS research through everyday practices of knowledge production. Inclusion and exclusion in the production of knowledge in participatory GIS are mediated within several intersecting arenas of research practice simultaneously, often with contradictory implications, priorities, and outputs. **Key Words:** participatory research, qualitative methods, PPGIS.

I don't know very much about what is happening in [our GIS lab], because when I came to work here, they told me nobody was allowed to touch those computers except for you and Juan. And besides, I don't know much about computers or maps anyhow.

(Jose, community organizer, 2004)¹

In the context of a participatory research project intended to foster sustainable geographic information system (GIS) capacities in community-based organizations, this remark by a community organizer was an unpleasant surprise. Beyond the immediate concerns it raised about the nature of participation in this project, the statement highlights tensions endemic to participatory research incorporating methods and techniques such as GIS, remote sensing, and a host of other quantitative, digital, or statistical forms of spatial data and analysis. It also illustrates some of the intersecting forces that shape participation in such research contexts, in this instance revealing dual exclusions of institutional gatekeeping in the workplace as well as technological and expertise barriers presented by the GIS.

The notion that research should actively involve individuals and social groups affected by it has been promoted in popular education

movements (Freire 1970; Fals-Borda and Rahman 1988), environmental justice activism (Merrifield 1993; Heiman 1997), and in several areas of feminist research (Strand et al. 2003; Brydon-Miller, Maguire, and McIntyre 2004). A commitment to research practices based on nonexploitative collaboration with communities affected by them has long been a core component of research in feminist geography (Gibson-Graham 1994; Nast 1994; Moss 1995; Rocheleau 1995; Breitbart 2001; Kobayashi 2001; Smith 2001). Pain (2003) has documented rising use of participatory approaches in other parts of the discipline, including political ecology (Robbins 2001; Nightingale 2003), social geography (Kesby 2000; Kitchin 2001; Kinson 2003), and critical urban geography (Lees 1999; Collins and Kearns 2001). Across these diverse participatory research contexts, the existing literature places special emphasis on the politics and power relations of the research process. In these discussions, the emancipatory potential of participatory research is understood to stem in part from the ways it alters these processes and relations. Specifically, participatory research seeks to foster self-determination of research questions, methods, and application of findings by individuals and groups affected by the research; expand participants' access to and

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control over information produced; and include a greater range of types and sources of knowledge (Park et al. 1993; Tolman and Brydon-Miller 2001). In its emphasis on the relevance of multiple forms of knowledge and the inherent partiality and situatedness of knowledge, participatory research is strongly informed by feminist theory and method (Smith 2001; Brydon-Miller, Maguire, and McIntyre 2004).

Participatory research that incorporates GIS applications as a core part of the research process, sometimes termed "public participation GIS" (PPGIS), has grown tremendously over the past decade. Conducted in many different kinds of GIS applications, PPGIS research is rooted in an understanding of the contradictory capacity of GIS technologies to empower and disempower, and in a commitment to fostering bottom-up GIS applications that incorporate diverse forms of local knowledge and participation (Sieber 2004). As a form of participatory research, PPGIS presents some unique challenges with respect to incorporating multiple and diverse forms of spatial knowledge and building broadly inclusive research processes. Although PPGIS is discussed extensively in research on the social and political impacts of GIS, the existing literature has not explicitly situated PPGIS as a form of participatory research. The PPGIS literature has shown that the knowledge production practices of a PPGIS initiative are a central mechanism mediating its impacts on participation and power, and has illustrated how social and political identities and power relations shape the participation and role of individuals and institutions (Harris and Weiner 1998; Aitken 2002; Elwood 2002). But this body of research has been less focused on how participation in GIS-based knowledge production is negotiated in a range of everyday practices in PPGIS projects. In so doing, it has not offered detailed accounts of how participation and representation are negotiated in the grounded decisions and practices of PPGIS research, even while providing a wealth of practical strategies for conducting effective and sustainable PPGIS initiatives.

To illustrate how participation and representation are mediated in the practices of a PPGIS initiative, this article draws on experiences and observations in a participatory GIS project conducted with two Chicago community organizations. Specifically, I show how participation in

knowledge production is negotiated in these practices through multiple mechanisms simultaneously, often fostering both inclusion and exclusion, as well as producing contradictory priorities and strategies for social and spatial change.

Participatory Research and the Politics and Practices of Knowledge Production

The practices, politics, and power relations of knowledge production are central to discussions of participatory research methods and their social and political impacts. Here, I use knowledge production to encompass multiple elements of a research process, including formulation of research questions or conceptualization of problems to be examined; types and sources of information gathered and means of analyzing that information; and interpretation and dissemination of findings and results. In the context of PPGIS initiatives, visualization is also an important component of knowledge production, as maps and other visual images are used to produce and communicate spatial meanings. This conceptualization is not meant to encompass all ways that individuals and social groups produce knowledge. Rather, I use it to mark an extended terrain in which knowledge is negotiated in research practices, one that the PPGIS, participatory, and feminist research methods literatures argue is essential for understanding how participation and power are structured in research.

These related literatures have identified several kinds of structures that shape participation and representation in knowledge production. Some researchers have focused on the discursive power of different types of knowledge, noting the extent to which some forms of knowledge are granted greater legitimacy than others in social and spatial decision making. Knowledge developed through traditional scientific paradigms and practices (often termed *rationalist*, *instrumental*, or *expert*) or the use of technologies like GIS is frequently considered more legitimate and relevant (Aitken and Michel 1995; Sandercock 1998). Knowledge acquired through lived experience, often termed *local knowledge* or *experiential knowledge*, is generally granted less legitimacy and sometimes

deemed biased because of its close connection to research participants (Gaventa 1993; Heiman 1997; Elwood 2002). Other researchers focus on how individual and institutional roles, identities, and relationships affect the knowledge produced in participatory research (Katz 1994; Breitbart 2001, Tolman and Brydon-Miller 2001; Monk, Manning, and Denman 2003). These scholars note close connections between identity, subjectivity, and knowledge, arguing that the meanings and interpretations that participating individuals and social groups produce in research are shaped by experiences and knowledge that may be differentiated along lines of race, class, gender, and ethnicity (Nast 1994; Kobayashi 2001; Smith 2001). Finally, the participatory research methods literature has illustrated the influence of research methods and techniques on participation in knowledge production. Some scholars advocate for qualitative interpretive research techniques, arguing that they are essential for eliciting and validating multiple perspectives and social groups (Brydon-Miller 2001; McIntyre and Brinton-Lykes 2004). Others have shown how quantitative research techniques and technologies like GIS or remote sensing can be used in ways that foster similar goals (Rocheleau 1995; McLafferty 2002).

With this broader literature on participatory research, PPGIS shares a commitment to research practices that incorporate diverse and potentially oppositional priorities, and include the knowledge and perspectives of multiple social groups, particularly those that are socially, politically, or economically marginalized. But participatory research projects that incorporate GIS present some unique concerns and potential limitations. The skills and financial and temporal costs of using GIS effectively bar many individuals, social groups, and organizations from participation in research and decision-making where it is used (Leitner et al. 2000; Ghose and Huxhold 2001; Weiner and Harris 2003). Others have argued that GIS most easily incorporates forms of knowledge that are quantitative and visual, and supports rationalist making, potentially marginalizing other forms of knowledge and logic (Aitken and Michel 1995; Pickles 1995; Rundstrom 1995; Sheppard 1995). Exploring these claims, researchers have examined whether diverse individuals and social groups are able to become directly involved in research or decision making that uses GIS, and

the extent to which the technological and representational practices of GIS can incorporate multiple forms of knowledge and decision-making paradigms (Obermeyer 1998; Sieber 2004). While acknowledging the limitations of GIS in both areas, other researchers emphasize the social constructedness of GIS-based research and decision making. They emphasize that the epistemologies and representational practices of GIS are not fixed, but may be adapted in ways that redress some of these limits (Sheppard 1995; Kwan 2002b; Schuurman 2002).

Responding directly to these calls for a reconstruction of GIS, PPGIS attempts to alter GIS technologies and GIS-based research and decision-making processes to address these concerns. Some interventions seek to adapt GIS data structures and spatial analysis techniques to incorporate qualitative data, sketch maps, or photographs, sounds, and other non-Cartesian representations of space (Al-Kodmany 2000; Krygier 2002; Kwan 2002a). Interventions in the participatory processes in which GIS is used have included strategies for incorporating local spatial knowledge in these processes. Such adaptations include collaborative mapping exercises, community review and critique of spatial data developed for a GIS, collective field work to gather data for a project, or community conflict mediation through a GIS application (Harris and Wiener 1998; McLafferty 2002; Williams and Dunn 2003; Kyem 2004). These techniques are intended to elicit local knowledge for GIS-based decision making, involve participants in use of the GIS and spatial data generated, and ensure that a diverse range of participants decide how and for what purposes the GIS will be used. Throughout, the literature emphasizes the extent to which these and other aspects of PPGIS initiatives are context dependent, identifying a host of factors that shape their effectiveness, sustainability, and participatory practices. Specifically, researchers note the influence of organizational capacities for implementing technologies (Sieber 2000), institutional resources and networks that support PPGIS development (Ghose and Huxhold 2002; Elwood and Ghose 2004), and local political or institutional cultures of participation and information sharing (de Man 2004; Norheim 2004).

PPGIS research has developed many strategies for using GIS software and digital spatial

data in participatory research and decision-making processes, created strategies for sustaining PPGIS initiatives, and identified multiple factors that affect the processes and outcomes of PPGIS initiatives. But this focus in recent years on facilitating effective and sustainable PPGIS and identifying its contingent factors has meant relatively little attention has been given to how participation and representation are negotiated in the daily practices of participatory GIS research. The existing literature demonstrates that the nature of participatory knowledge production in PPGIS is the result of complex intersections of technological and social factors, but there have been relatively few attempts to detail how these intersecting factors play out in and are shaped by the daily choices and negotiations of PPGIS projects. That is, what are some of the specific everyday practices in PPGIS research through which participation in knowledge production is negotiated? Explication of such specific practices is important in part to further detail the social and political contexts that are argued to shape participation and representation in GIS use. Discussion of the grounded practices that mediate inclusion and exclusion in knowledge production in PPGIS also provides a potentially important resource for PPGIS participants, suggesting some tangible ways to identify key choices in the everyday practices of these projects that are likely to influence participation, power, and knowledge production.

In this article, I illustrate some of the everyday practices of knowledge production through which participation and representation are negotiated, including negotiations over the sources and forms of knowledge that will be used and prioritized; ways of using particular research methods and techniques; local and institutional practices and cultures of participation; and ways of representing, disseminating, and applying knowledge produced in the research process. I will show that participation in knowledge production in PPGIS research is structured by these multiple mechanisms simultaneously, often with contradictory implications in terms of participation, inclusion, and representation.² PPGIS practice is characterized by series of trade-offs and compromises around these contradictions. This account of participatory knowledge production as negotiated through multiple mechanisms simultaneously, with con-

tradictory implications for participation and power, complicates discussions of local knowledge in much of the literature on PPGIS and participatory research. In discussions of the practices of participatory research, both literatures tend to juxtapose local knowledge against other kinds of knowledge, whether termed expert, official, or hegemonic. This juxtaposition has potential to obscure ways in which these forms of knowledge are often closely intertwined in the everyday practice of participatory research.

The Humboldt Park GIS Project

This article is developed from observations and experiences in an ongoing research and education project with two community development organizations in Chicago's Humboldt Park neighborhood. As a result of several decades of disinvestment and decline in the area, many Humboldt Park residents experience problems of poverty, job loss, declining infrastructural conditions, insufficient affordable housing, and high crime rates. The conditions are experienced somewhat differently by the Latino residents of east Humboldt Park and the African American residents of the west side. The organizations involved in the project discussed here are two of many nonprofit community groups active in Humboldt Park. Both organizations seek to improve neighborhood quality of life through capital investment in the built environment, community organizing, some direct service provision, and policy advocacy with local government.³ Organization participants include paid staff, volunteers, and board members, most of whom live or work in the neighborhood. With respect to organizational resources and capacities, both groups have four to seven paid staff members and are funded by a shifting array of city, state, federal, and philanthropic sources.

The Humboldt Park GIS Project emerged as a collaboration between these two community organizations, a university-based urban research institute, my work as an academic researcher, and undergraduate students working as research assistants or participating in community service learning activities in my geography courses. The project is building resources to enable the two community groups

to use GIS, and to carry out community-designed applications of these GIS resources to their neighborhood revitalization efforts. The project's activities also inform some of my research questions about the use of GIS-based spatial knowledge in urban politics. Prior to the project, nearly all staff members at both groups used computers for information management, but had no prior GIS experience. Our collaboration was initiated by an urban research institute at a Chicago university that has helped Humboldt Park nonprofit agencies connect with faculty for collaborative research and technical assistance.⁴

Our specific activities included developing a spatial data library of information that staff and volunteers at the two organizations identified as useful for their work; setting up hardware and software for GIS use on site at their offices; and facilitating initial GIS training and ongoing tutoring for staff members.⁵ The community groups use these resources to produce their own maps and analyses independently, but we have also done collaborative GIS projects in which I, community participants, research assistants, and students in my urban planning and GIS courses worked together. Choices about data development goals and specific applications of the GIS are made by the staff and residents. The research assistants and I play advising and technical assistance roles, acquiring some of the needed data for the spatial data library, advising on how a particular GIS application devised by the staff might be implemented, and making weekly visits to tutor staff members as they build their GIS skills. Community participants not directly using the GIS or spatial data library contribute to its development and application in other ways, specifying information needs, reviewing and critiquing secondary data, and providing feedback on maps produced. In the following section I focus at length on how participation and representation in knowledge production are structured through the everyday activities and choices of this project. In the Humboldt Park GIS Project, these choices are negotiated among me, the community participants, and research assistants, though with an eye toward having the community participants make substantive decisions about the acquisition and development of spatial information and application of the GIS resources in their work.

Negotiating Inclusion and Exclusion in Knowledge Production: The Everyday Contradictions of PPGIS

Observations from the Humboldt Park GIS Project suggest that participation and representation in knowledge production are negotiated in several arenas simultaneously. In the daily practices of PPGIS research, some forms of knowledge are given priority over others, whether in the GIS itself or in the processes in which it is used. Local political and institutional expectations and practices for citizen participation shape opportunities for involvement in GIS-based knowledge production and application. Individual and institutional participants make a variety of choices about how to use GIS, and how to represent and apply the knowledge produced. These everyday practices and decisions in PPGIS projects are not made in isolation, of course. They occur within complicated and shifting social and political processes, in ways that tend to foster both inclusion and exclusion in the knowledge production practices of PPGIS initiatives.

Knowledge Priorities

The critical GIS literature has clearly illustrated the greater ease of incorporating quantitative, standardized, and cartographic forms of knowledge into GIS-based research and decision making than into other forms of knowledge (Pickles 1995). However, the inclusion or exclusion of particular kinds of information is also shaped by knowledge priorities of the involved individuals and institutions in a PPGIS project. For instance, if the community researchers in a participatory project are affiliated with an agency or community group, the information these institutions prioritize will affect the engagement of potential participants. If an agency considers residents' oral testimony about community concerns to be its most relevant source of information, participatory research with this organization is likely to engage residents who are able and willing to contribute in this manner. If the community researchers and institutions prioritize accounts of neighborhood conditions derived from census data or local government statistics, participation can change dramatically, potentially enabling the involvement of individuals who have access to and familiarity with these forms of information and constraining the

participation of those who do not. It is important to consider the knowledge priorities not just of academic and community researchers who are direct participants, but also of the actors and institutions with which the community researchers will interact as they apply their findings. Community researchers have a detailed understanding of strategies and discourses of community change that are likely to influence these other actors, and this expertise strongly influences the types of knowledge they produce.

Knowledge priorities affect participation in the Humboldt Park GIS Project in several contrasting ways. Within one of the collaborating organizations staff members prioritize very different types of spatial knowledge, stemming from differences in their respective strategies for neighborhood improvement. One staff member tends to appeal for greater commitment of local government financial and regulatory resources by documenting infrastructural neglect and its effects on residents' daily lives. Another staff member seeks to form partnerships with private business investors by demonstrating investment opportunities in the neighborhood. The types of information these organizers use to support these revitalization strategies are quite different. The first organizer prioritizes experiential knowledge of residents, using their photographs and oral accounts to document hazards they experience daily from holes in sidewalks and streets, missing and obscured traffic signs, rodent infestation, and other kinds of infrastructural deterioration. The second organizer relies on forms of knowledge that can communicate material and financial opportunities for businesses, such as comparatively low property prices and rents, lot sizes, square footage of existing buildings, and vacant land available for development. The knowledge priorities of these two organizers directly affect the extent to which they are able to involve community residents. In the first case, most residents are much more able to contribute information by describing problems, sharing photographs, and taking staff members and local officials to visit problematic sites. Residents are less able to contribute knowledge supporting the second organizer's efforts because most of that information is derived from local government and real estate data sources.

The community researchers' choices about knowledge production in this project are also

strongly influenced by the priorities of local government and private developers with whom they negotiate, advocate, and compete for control over neighborhood development. These government officials and developers prioritize quantitative standardized forms of knowledge, and visual images such as maps, design sketches, and photographs. Directly citing these preferences of powerful actors in their community, the participating organizations' first goal for the project was to acquire these types of the data for the spatial data library, even while they noted that this choice might fail to represent some residents' experiences. It is important to recognize that these groups do not adopt official data uncritically or intend for it to be their only information source. Like most community activists, these participants are deeply critical consumers of these types of data and are keenly aware of the need to include other types and sources of information about the neighborhood. Staff members explain that they want these official data in part so that they can critique or reinterpret their representation of community needs and conditions. As one organizer explained, "We need the [U.S.] census data so we know what it says about us. But then we need to do our own census so we can show where it's wrong, where the City doesn't understand how things really are for people in our community" (Damien, community organizer, 2003).

For the spatial data library, the community participants have encouraged development of overlapping data that provide multiple sources of information addressing the same issue. For instance, one community group is obtaining data on parking needs and traffic counts from the City of Chicago's transportation division while also gathering its own information on neighborhood traffic patterns from the observations of residents and businesses. Both community groups assess spatial patterns of income, demographics, and housing costs using official accounts, but also use parallel information gathered from residents and the field observations of their community organizers. This strategy of creating overlapping data seems intended to expand the range of participants who can use these data and diversify the discourses of neighborhood needs and assets that may be developed from them. This approach also enables community researchers to strengthen their critique

of information they deem inaccurate in its representation of the community.

Local/Institutional Relationships and Cultures of Participation

Participatory knowledge production is also shaped by local or institutional relationships, cultures, and past experiences. More specifically, practices and relationships of information sharing, coalition building with other agencies, lines of authority in community associations, and staff development can all influence participation in GIS-based knowledge production. In some cases, these factors have been discussed in the literature as part of the social and political contexts that shape PPGIS (Ghose and Huxhold 2001; Elwood and Ghose 2004).

In the Humboldt Park GIS Project, the presence of organizational structures limiting access to the GIS and data resources of the project was illustrated at the outset of this article. Though this staff member described being forbidden to use the computers in the GIS room, additional observation revealed a more complicated picture of the effect of institutional needs and practices on decisions about access to the lab. The organization's leaders, concerned about their limited resources for technology-related problem solving, had not forbidden staff to use the lab altogether, but rather had forbidden uses that did not involve the GIS or information from the spatial data library. In this instance, access to the lab and participation in its research-related activities was limited because of the participants' assessment of potential problems and organizational capacities to solve them. Simultaneously, the same organization cultivates a strong commitment to expanding staff members' skills in ways that tend to expand involvement in activities of the mapping lab and the GIS project. During regular visits to the organization's office for GIS tutorials with one or two staff members, we usually found many more staff members waiting in the lab, even those with no GIS experience. As one of the staff members explained after recruiting several of her colleagues to attend a session exploring new information for the data library, "I need to get everyone else in here too, so they could use this information for their work. Even if I'm the only one who knows how to use the GIS right now, we need everyone to understand what we have so they can start thinking about how it could

help their work" (Maria, community organizer, 2004).

Over time, I observed staff members teaching one another new computer skills in the lab, sharing maps and information they had developed, and also working with my undergraduate GIS and urban planning students to share experiential neighborhood knowledge and GIS skills. These inclusions exist alongside intentional restrictions on access to the GIS labs at both organizations.

The everyday participatory practices of these community research partners are also affected by local practices related to citizen participation, information access, and coalition building. In Chicago, these relations and practices affect the Humboldt Park GIS Project in contradictory ways. Chicago's local government has a long history of resisting participation of community-based organizations that seek to operate outside of its electoral ward system (Ferman 1996; Rast 2001; Hamilton 2002), as both of the partner agencies seek to do. The participation of these and other grassroots groups is constrained in part because aldermanic wards are the primary and officially recognized mechanism for citizen participation in local policy and decision-making. Both groups have found that many city agencies strongly resist sharing data, even where these data may be in the public domain.⁶

In this context, the capacity of the Humboldt Park GIS Project to expand the community organizations' independent critique and interpretation of such data, and perhaps to use their analyses to leverage greater participation in local decision making is severely restricted. However, in terms of information sharing among local community organizations, both agencies are fostering a distinctly different culture of data access through the project. Both groups actively share data and maps with other community organizations and use the GIS resources in collaborative activities with these other groups. In this case, local and institutional structures of participation serve as both catalysts and barriers to expanding involvement in GIS-based knowledge production.

Choices About Research Methods and Techniques

The epistemological assumptions and practical requirements of using a particular research

method or technique have a strong influence on participatory practice in research. But the effects of research methods and techniques on participation in knowledge production are not only determined through choices about which methods to use, but also in choices about how to use them. Throughout a PPGIS project, different participants may make shifting choices about how to use GIS and how they will try to address some of its barriers to participation. In the Humboldt Park GIS Project, direct use of the software is limited to a few participants with GIS skills. However, the organizations are nonetheless taking steps to use GIS in ways that enable participatory exploration, analysis, and critique of the project's data, especially through visualization. Observation of residents and staff members reviewing, discussing, and using the maps produced in the early stages of the project reveals that these visual representations seem to be relatively accessible for many neighborhood participants. The organizations have sought to involve staff and residents without GIS experience in several aspects of GIS-based knowledge production: specifying what information should be included and how it should be displayed, identifying needed maps for certain programs or problem-solving efforts in the neighborhood, and critiquing the usefulness of these emerging representations.

These day-to-day decisions about how to implement and apply GIS in the Humboldt Park GIS Project involve weighing the implications of different strategies and goals for fostering participatory knowledge production. For instance, we prioritized the direct involvement of community participants in using the technology over efforts to adapt it to incorporate qualitative experiential forms of neighborhood knowledge. PPGIS research has developed a wide array of multimedia and Internet GIS approaches we could use to incorporate these types of data (Shiffer 1998; Al-Kodmany 2002; Krygier 2002; Sieber 2004). However, implementing many of these approaches would raise the level of technical skill required for direct use of the GIS, far outstripping the current skills of the community researchers who very much want to use the technology themselves. Asked how the GIS resources might be most useful to his organization's activities, one staff member clearly indicated this priority, saying, "I guess the number one thing is show us how to use it!

That would be the most important, showing us how to use it." (Max, community organizer, 2004).

In this instance, attention to what participants said (or demonstrated through their actions) about their priorities for use of the GIS charted a clear course for how to balance direct use of the GIS by participants with efforts to adapt the technology to include more diverse data. We focus on fostering basic GIS familiarity in as many of the community participants as possible, with an eye toward choosing data types and mapping strategies that meet community information needs with the minimum level of technical expertise required. As well, we try to situate the GIS and spatial data library within a more inclusive process of information gathering, to involve diverse range of participants in preparing data for GIS applications, and in review and critique of primary and secondary data and maps developed or obtained for the project.

Representations of Spatial Knowledge and Research Results

Participation in PPGIS research is also negotiated through representations of people and place in research findings, reports, and data. These representations may vary greatly in terms of the inclusiveness of their content and their accessibility to a diverse range of potential users. In the Humboldt Park GIS Project, our examination of the content, formats, audiences, and potential meanings of the maps created indicates that these representations sometimes expand participation by diversifying discourses about neighborhood needs and conditions. But simultaneously these GIS-based representations of the neighborhood are not equally accessible to all residents participating in the organizations' planning and decision-making efforts.

For example, the community groups have used a series of maps of demographic, housing, and income characteristics derived from U.S. Census data to reinterpret neighborhood needs very differently than local policymakers' readings of the same data. By using a different spatial scale and resolution to map household income, they challenged the income threshold set by local government for affordable housing, illustrating that housing deemed affordable was out of reach of most Humboldt Park households. In this instance, the GIS was used to open up opportunities for the organization and the

participating residents to produce knowledge that helped them gain active involvement in policy revision efforts. But in another instance, these same census maps were less effective in fostering participation in knowledge production. The staff at one agency used these maps at a community planning meeting to try to foster a discussion connecting residents' concerns on their individual blocks with broader patterns in the community as a whole. The participation of residents in this discussion was minimal, with several people indicating confusion about the maps, census data, and information being represented in them. Therefore, in contrast to their usefulness in advocating for the community with local government, these representations were not sufficient for eliciting discussion from residents that might have further detailed and contextualized the census data with local experiential knowledge.

These ambiguities illustrate the importance of using multiple ways of representing and communicating spatial knowledge in participatory research that uses GIS, but they also illustrate the challenges of doing so. Residents' experiential accounts of some of the same neighborhood characteristics and conditions represented in the census data could be included in the GIS, perhaps through multimedia GIS adaptations that would enable inclusion of sketch maps, sound recordings, or textual commentary. But this approach would likely require greater skills for community researchers to be directly involved in developing and using the GIS. Representing local knowledge in multimedia forms might also necessitate disseminating maps online in a community where very few residents have Internet access. For these reasons, at the time of writing both of the community groups primarily seek to include residents' experiential spatial knowledge in organizational activities alongside the representations they produce using the GIS, rather than trying to incorporate them directly into the GIS. This approach may shift in the future and does not necessarily preclude other strategies. One of the organizations is beginning to develop a spatially referenced record of infrastructural problems observed and experienced by residents, with an eye toward being able to incorporate this information into their GIS applications.

A key element of effective participatory research involves ensuring that its findings are

accessible to a diverse range of potential users, represented in ways they can understand and apply. Several practical issues may emerge with respect to the accessibility of research outputs, depending on how the results are represented and what skills and resources are needed to understand and use them. One of the early efforts of the Humboldt Park GIS Project was a study produced by the community researchers and participating students. Containing about 150 maps, the study involved a field survey of conditions and land uses at approximately one thousand properties in the neighborhood's business districts and development of several other new data layers, including public, private and nonprofit social service providers; open lands; and sites of cultural or other community significance. Given that participants have varying computer or GIS skills and experience in using maps and spatial data, we took several steps to broaden the accessibility of the resulting maps and report. The study includes extensive explanation of data sources and development processes, categorization schemes used and their relationships to "real world" conditions, and accuracy and reliability issues. To facilitate use by participants ranging from those with no computer access to those with GIS access, we produced the study in hardcopy format, in digital image files, and as GIS-based spatial data files. The hardcopy maps and digital images do fix these representations such that users cannot modify their scales, resolutions, or content. However, early feedback on use of the community study suggests participants are nonetheless able to use these representations in a wide range of situations by adapting their interpretation or presentation of the maps.

Conclusion

Participation and representation in the knowledge production efforts of the Humboldt Park GIS Project are negotiated simultaneously in many aspects of the everyday practices of the project in sometimes contradictory and ambiguous ways. Participants may disagree about types of knowledge to prioritize, or may choose to prioritize knowledge they know is influential with powerful institutions but not broadly inclusive of a range of community priorities. Organizational or local political practices may encourage participation in knowledge produc-

tion in some activities and directly obstruct it in other instances. Representations of research results reveal similar ambiguities, with some representational forms proving to be accessible and useful for some audiences and situations but not for others. Using GIS in ways that expand the forms of spatial knowledge that can be included may have the unintended consequence of limiting the capacity of some participants to use GIS or gain access to maps and data produced.

Of course these everyday negotiations in PPGIS will also affect the forms of knowledge that are or are not produced. My discussion here has not directly examined the knowledge itself that emerges from this and other PPGIS initiatives. However, from the empirical examples included here, it is evident that the ways of knowing and GIS-based knowledge represented in the Humboldt Park GIS Project are constrained in several ways, such as the predominant focus on material conditions in the neighborhood. Detailed assessment of the knowledge that is or is not produced from participatory GIS initiatives must be included as an important part of future research in this area.

A central tenet of PPGIS practice is its commitment to incorporating local knowledge and representing multiple perspectives, but the ambiguities of the everyday practices that negotiate knowledge production in PPGIS illustrate the challenges of doing so. In these challenges, we see the contradictory social and political implications of GIS technologies extending into the participatory research process more broadly. This paper does not seek to propose a means of eliminating these ambiguities, but rather it illustrates how they may emerge through the grounded practices of PPGIS research. Critical observation of these contradictory moments in the everyday practices of PPGIS may well suggest ways of navigating them to ameliorate some exclusions or highlight these exclusions to other participants for further discussion. However, these interventions must be guided by recognition of one of the fundamental assumptions of participatory research: the partiality of the knowledge and power of any participant, including the academic researcher. As Breitbart (2001) noted, there is no ideal participatory research project, only ongoing attempts to foster more robust and diverse participatory practices. Along similar lines, Esnard, Gelobter, and Morales (2004) have argued that the goals

envisioned for PPGIS are often difficult to realize fully in practice. For these reasons, what we can and should do is to identify key moments of inclusion and exclusion in the everyday negotiations of the research project, and work with them in ways that strive to more fully and consistently realize the empowerment potential of this form of participatory research. ■

Notes

¹ All quotations are drawn from participant observation and informal discussions with research participants. In keeping with our confidentiality agreements, they are identified by a pseudonym and job title.

² As has been well documented by feminist researchers, participation, inclusion, and representation are strongly influenced by the identities, subject positions, and power relations among participating individuals and social groups. The influence of these factors on GIS-based research is already well developed in the critical GIS literature, so I focus here on the grounded practices of research.

³ PPGIS research focusing on grassroots organizational capacities (see Elwood and Leitner 2003; Elwood and Ghose 2004) has shown that community development corporations (CDCs) tend to have greater resources to support GIS use than do community-based organizations (CBOs). The activities of these two case study groups include capital development and community organizing, so they are not easily classified as CDCs or CBOs, a situation that community development researchers suggest is increasingly common (Stoecker 2003).

⁴ The generally positive relationship between my university and the participating organizations was complicated by both groups' past experiences of failed collaboration with other faculty, and the university's role in the gentrification of neighborhoods to the east, from which many current residents of Humboldt Park were displaced.

⁵ As in other PPGIS projects with grassroots groups, staff turnover and limited staff time present challenges to sustaining GIS capacity. To try to account for this difficulty and to help participants retain and expand their skills, we have designed skill-building activities that repeat regularly and include multiple participants in each organization.

⁶ Other Chicago-based community organizations I have worked with report instances of waiting years for public data requested under the federal Freedom of Information Act, and have had little success in obtaining these data in digital form. Unlike cities such as Milwaukee, Tucson, or Portland, Oregon, the City of Chicago does not make parcel-level GIS files and spatial data available online to public users.

In 2004, an Internet mapping site enabled limited querying and printing of maps from the Department of Zoning.

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