Public Participation Geographic Information Systems: A Literature Review and Framework

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Public participation geographic information systems (PPGIS) pertains to the use of geographic information systems (GIS) to broaden public involvement in policymaking as well as to the value of GIS to promote the goals of nongovernmental organizations, grassroots groups, and community-based organizations. The article first traces the social history of PPGIS. It then argues that PPGIS has been socially constructed by a broad set of actors in research across disciplines and in practice across sectors. This produced and reproduced concept is then explicated through four major themes found across the breadth of the PPGIS literature: place and people, technology and data, process, and outcome and evaluation. The themes constitute a framework for evaluating current PPGIS activities and a roadmap for future PPGIS research and practice. *Key Words: community-based organizations, geographic information systems, grassroots groups, PPGIS, social construction.*

It is an odd concept to attribute to a piece of software the potential to enhance or limit public participation in policymaking, empower or marginalize community members to improve their lives, counter or enable agendas of the powerful, and advance or diminish democratic principles. However, that is exactly what has happened with geographic information systems (GIS), the social application of which has captured the attention of researchers in diverse disciplines including urban planning, law, geography, library science, social work, landscape ecology, anthropology, agricultural economics, natural resources, and conservation biology. Projects have tended to be guided not by esoteric academic interests but by grassroots groups and community-based organizations (CBOs) that use GIS as a tool for capacity building and social change. The use of GIS has been furthered by members of the public and private sectors who believe that access to computer tools and digital data forms an essential part of an informationally enabled democracy. Finally, the research and practice have been propelled by academics who are engaged, not simply in studying the application of GIS, but also in promoting the normative activity of broadening access to GIS.

Attributing empowerment to technology is not new; several of the same opportunities and challenges were voiced about rural electrification and telephony (Tobey 1996). GIS has sparked interest for three main reasons. First, most information used in policymaking, whether with regard to crime, land-use planning, environmental health, habitat conservation, or social service provision, contains a spatial component (e.g., address, zip code, and latitude/longitude). Second, extending the use of spatial information to all relevant stakeholders presumably leads to better policymaking. Third, as Wood (1992) argues, this policy-related information can be analyzed and visualized spatially, and the resulting output (mainly maps) can persuasively convey ideas and convince people of the importance of those ideas. Add to these reasons the sheer volume of spatial data from numerous disparate sources and across themes and scales as well as the increasingly affordable and easy-to-use systems. On the surface, the connection between empowerment and GIS appears certain and replete with possibility.

Arguments that GIS alone can guarantee empowerment consequent to a particular decision-making process or that spatial information divorced from its sociopolitical context can improve understanding are, not surprisingly, controversial. A substantive critique holds that GIS represents yet another instrument of capital control and government surveillance (Pickles 1995; Curry 1998; Aitken 2002). This lens frames GIS as a return to positivism in which its users quantify passionately held positions and reduce complex societal processes to points, lines, areas, and attributes. Use of the technology lends the illusion of control over decision making when actual control remains within the governing class. Further promotion, indeed evangelism, of GIS distracts grassroots groups and others from proven activist strategies such as protest and retreats from questioning the overall framework of policymaking and distribution of power. Nuancing the applications with extra attributes and lowering the entry costs of computing cannot dispel what are considered to be intrinsic problems with GIS.

In spite of or to counter the critiques, the field of public participation geographic information systems

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(PPGIS) emerged. PPGIS was originally defined as "a variety of approaches to make GIS and other spatial decision-making tools available and accessible to all those with a stake in official decisions" (Schroeder 1996). Since 1996 numerous PPGIS and related conferences (U.S. National Center for Geographic Information and Analysis Varenius Workshop 1998; Workshop on Access and Participatory Approaches in Using Geographic information in Spoleto, Italy 2001; International PPGIS Conferences 2002-5; and Mapping for Change, Nairobi, Kenya 2005) have brought together diverse disciplines and communities to coinvestigate the promise and challenge of GIS. Special journal issues of *Cartography and GIS* (1998, vol. 25 [2]); *Environment and Planning B* (2001, vol. 28 [6]); *Urban and Regional Information Systems Association Journal* (2003, vol. 15, APA I, II); and *Cartographica* (2001 [published 2004], vol. 38 [3&4]) have furthered explorations in, for example, data accessibility, development practices, and evaluation strategies.

However much PPGIS has evoked interest from researchers and practitioners, there has yet to be a comprehensive literature review. This deficit is partly due to the emergent nature of the literature but also prevails because PPGIS activity is distributed among disciplines, economic sectors, and formats (e.g., peer-reviewed academic journals, vendor reports, and grassroots websites). Tulloch (2003) argues that this scattering provokes an identity crisis in PPGIS, bereft of a common lexicon even of words such as *public* and *participation*. In this PPGIS Tower of Babel the following disparate applications coexist: a spatial decision support system that is designed by The Nature Conservancy for other nonprofit organizations, a web-based municipal GIS that serves local real estate agents, a GIS application that optimizes nuclear power plant siting, a museum of technology that exhibits GIS tools (Schlossberg and Shuford 2005), and a community mapping exercise that involves GIS software long after the exercise is completed and far away from the community. Instead of fragmentation, this article argues that diverse venues have reshaped the original concept of PPGIS. From a collection of tools to increase access in official policy circles, PPGIS has metamorphosed into a coproduced concept composed of multiple disciplinary approaches and actors, rapidly changing technologies, and numerous as well as occasionally transgressive goals.

This article reviews and frames the work of PPGIS. It begins by tracing the social history of PPGIS, a history that reveals the way in which actors from varied disciplines and sectors have mutually constituted PPGIS. This coproduced PPGIS is then characterized by four themes, which are termed place and people, technology and data, process, and outcome and evaluation. The themes elucidate the breadth introduced through the coproduction of PPGIS and the resulting degrees of freedom comprising PPGIS projects. In tracing the past and explicating PPGIS thematically, this article seeks to provide a roadmap for future research and practice within the field of PPGIS. Technological innovations will continue and new actors and applications will be added. It is hoped that these and other individuals will express their engagement in PPGIS in terms of the mutual narrative of PPGIS even as they participate in transforming its development.

A Brief Social History of PPGIS

The term PPGIS originated at two meetings of the National Center for Geographic Information and Analysis (NCGIA) as attendees struggled to frame the next generation of GIS, or GIS/2 (which was read as *two* or *too*) (NCGIA 1996a, 1996b) that would ground technical advancements in social and political contexts. These meetings reported on a growing affinity of GIS practitioners with developing applications that "empower less privileged groups in society" (NCGIA 1996b), and attendees declared that the next generation of GIS should be more inclusive to nonofficial voices (Obermeyer 1998a). The resulting definition of PPGIS focused normatively and ontologically on supply-driven and pragmatic approaches to engage the public in applications of GIS with the goals of improving the transparency of and influencing government policy (Schroeder 1996).

These early meetings were seminally influenced by the critiques of GIS mentioned above. The critiques, which became known as GIS and Society (GISoc), reflect a more general interest in the social nature and impact of GIS—that is, the choices made and foregone in the development of the technology, the numerous conflicting agendas in its use, and the impact of GIS on representing spatial information (Sheppard 1995; NCGIA 1996a). Although influential, GISoc represented an ontological divergence from PPGIS. GISoc asked the whether and why questions, whereas PPGIS was relegated to the how—that is, how to employ the theories to most appropriately apply GIS for social endeavors. According to Sheppard (1995, 15), GISoc was concerned with the social theory of GIS; whereas PPGIS was considered "GIS in practice." This framing of PPGIS situated the legitimate form of intellectual engagement within GISoc and with academicians. Additionally, it had the effect of normalizing the critique of PPGIS to the GISoc ontology of power relations. Concerns grew in PPGIS that this was fast becoming the sole acceptable critique of PPGIS (Obermeyer 1998a), as opposed to technical critiques or critiques within other ontologies (e.g., collectivism). These differences produced not an impassable divide but a creative tension. As a consequence, PPGIS has been infused with a reflective praxis to not accept as axiomatic existing resources, representations, or territoriality. It also has generated in PPGIS a skepticism of critique without prescription.

This creative tension is exemplified in recent calls to rename PPGIS to Participatory GIS (PGIS).[1] Individuals at the initial meetings on PPGIS expressed some apprehension that applications were beginning to overrepresent the advantaged (e.g., the haves in U.S. suburbs) and underrepresent marginalized peoples (e.g., the have-nots in communities without even the basics such as potable water). As a result, researchers have increased the number of nontraditional PGIS applications, primarily in developing countries (Abbot et al. 1998; Harris and Weiner 1998; Rambaldi and Callosa 2000; Kyem 2001). PGIS derives from community-integrated GIS (Harris and Weiner 1998) and what Peluso (1995) terms "counter mapping," mapping to contest the status quo. PPGIS continues to be the most widely used term, but each acronym brings its own contexts, methods, and actors to a collective understanding of PPGIS or PGIS.

PPGIS is considered by some to be subsumed into what is now called Critical GIS (Schuurman 2001). Critical GIS has become an umbrella to encompass all research on the societal effects of GIS (e.g., geosurveillance), the social processes that should or should not be modeled by GIS (e.g., gender movement in space), or the representation, ontology, and epistemology of GIS (Kwan 2002; Crampton 2003). This has accorded greater legitimacy to critiques of GIS within GIScience, important for standing in the GIScience community but also critical for resources such as laboratory space, funding, and graduate students. Identical to early formulations of GIScience (Wright, Goodchild, and Proctor 1997), there have been questions about whether PPGIS can be generalized as an objective scientific inquiry; whether it represents a collection of methods, in other words, part of the less legitimate GIStudies; and what are the costs of a positioning within science (Jankowski and Nyerges 2001; Sieber 2001). With respect to the history of PPGIS, movements toward science, like social theory, can strain relations between research and practice because the drive for legitimacy can appear to outweigh normative action.

The original definition of PPGIS has attracted researchers and practitioners from urban planning, community development, landscape ecology, as well as natural resources (e.g., see Morain 1999). These types of PPGIS projects concentrate on supporting various stages of a more collaborative planning process, such as disseminating planning-related information online, expanding the number of stakeholders in planning, easing the understanding of analyses through visualization, and weighting alternatives utilizing graphical user interfaces (Shiffer 1998; Talen 2000; Al-Kodmany 2001; Ball 2002; Drew 2003). The applications illustrate how PPGIS is manifest through specific disciplinary lenses.

Urban planners participated in the initial characterizations of PPGIS. Increasingly, researchers and practitioners in other fields such as social work are embracing PPGIS. PPGIS is conceived of as a method to map individuals by class, employment, ethnicity, religion, language, gender, and age; spatially analyze differential public mobility and access to social services; and comparatively visualize community deficits and assets (Plescia, Koontz, and Laurent 2001; Beever 2002; Hoicka 2002; McCall 2003). This is PPGIS as GIS, with top-down goals of understanding neighborhood dynamics, improving public sector management, and enhancing social service provision. Researchers new to the field have tended to constitute a somewhat technocratic view of PPGIS and their applications can lack extensive public interaction, other than perhaps to supply input, such as perceptions of street safety. Their views have challenged those originally engaged in PPGIS to derive a shared understanding of what PPGIS does and does not comprise.

Acronyms and concepts such as reconstituted identities were largely extraneous to long-standing PPGIS practice. A few years prior to the designation of the PPGIS concept, GIS began to be envisioned by nonprofit organizations as a useful technology for participatory projects (Aberley 1993; Poole 1995; Convis 2004). Their version of PPGIS emphasizes the technical—that is, the development of hardware tools such as solar-powered computers that can operate in the field and software applications such as scripts that can automate spatial analysis. The focus has tended toward spatial data collection, database design, and analysis as opposed to cartographic production. This has been accompanied by practical guides or instruction manuals, such as Eco-Trust's (1999) guide for conservation GIS and Tobias's (2000) manual for First Nation's use of GIS. With this group of practitioners, PPGIS describes relatively uncritical approaches to promote the goals of organizations outside the public and private sectors.

PPGIS research itself has undergone an evolution as participants seek to formalize the nature or process of PPGIS. Many of the early PPGIS efforts were exploratory case studies, which provided the "social narratives" of PPGIS (Kyem 2001, 5). These included studies of GIS by marginalized communities, nongovernmental organizations (NGOs) and grassroots groups (Convis 2001), native groups (Poole 1995), social movements (Sieber 1997), peoples in developing countries (Jarvis and Spearman 1995; Sedogo and Groten 2000; Kyem 2001), and urban CBOs (Craig and Elwood 1998). Whereas the earliest work showed the possibilities of GIS for grassroots environmental advocacy (Aberley 1993), the latest forms vary in technology and theory, for instance, implementations of web-based neighborhood information systems (Carver et al. 2001; Wong and Chua 2001; Kingston 2002), community resident-developed monitoring of the environment with mobile GIS (O'Brien 2003), and models of GIS availability in urban CBOs (Leitner et al. 2000). Research and practice have found common ground through venues such as frequently updated online bibliographies (e.g., http://www.iapad.org/bibliography.htm).

More recently, individuals engaged in PPGIS have gained awareness as a distinct community with the creation of new spaces of discourse such as the PPGIS conferences and the PPGIS.net listserve. It is in these venues that new forms of what it means to "do" PPGIS have emerged. Different parties have begun to negotiate what had previously been relatively static definitions of PPGIS. Instead of focusing on practice, the new discussions question which theories should form the basis of PPGIS and how much and when theory is appropriate to a project. It is in these forums also that the ostensible targets of PPGIS activities—members of the local communities and nonprofit organizations—have begun to collectively voice the future direction of PPGIS.

This social history frames PPGIS as being mutually constituted through numerous perspectives.[2] It adopts a social constructivist that individuals and organizations interact to develop and use technological systems and that interaction produces and reproduces those systems (Bijker, Hughes, and Finch 1987).

This approach holds that activities interlace the material and the discursive, that tools and tool-making cannot be rended from science and social theory. Research has already grounded GIS in social constructivism to explore these complex relationships (Harvey 2000; Sieber 2000a; Schuurman 2001; Harvey and Chrisman 2004). The interlacing of GISoc and PPGIS ontologies is one instance where PPGIS is being mutually constituted through the interactions of individuals and organizations. In another example, environmentalists have begun to reflect on the extent of participation and the value of adopting increasingly sophisticated GIS products (Convis 2001). Interactions also are seen in the fluid movement of individuals working with PPGIS among nonprofit, public, and private sectors. Researchers and practitioners have recognized that PPGIS is not an abstract exercise. The intersection of actors demands discourse across disciplines and responsiveness to people impacted by PPGIS projects. PPGIS resides neither in a single sector nor exclusively in the domain of geography. Understanding of PPGIS therefore requires a deeper interrogation of the technology, its actors, and their practices.

A Framework for a Coproduced PPGIS

This article examines the emergent themes and critical questions in PPGIS that course through disciplines ranging from law to conservation biology and venues such as academic classrooms and government offices. It blends the material and discursive, the varied applications and the contexts in which they are used. The coproduction of PPGIS plays out through four themes: place and people, technology and data, process, and outcome and evaluation.

Place and People

Multiple perspectives, particularly from PGIS, have illustrated that PPGIS is a highly localized activity, permeated with culture and sociopolitical influences. Yet findings obtained for one type of place and peoples often are applied to far different arenas. Systems developed in the United States may be employed in developing countries, in which the preexisting group relationships, available skill levels, and technological infrastructure are markedly dissimilar. A coproduced PPGIS must now consider specific contexts, stakeholders, and other actors, as well as the general public.

Context. A PPGIS project is not implemented in a void but rather is conditioned by the laws, culture, politics, and history of the community, city, region, or nation in which it is applied (Laituri and Harvey 1995; Elwood and Ghose 2001; Ghose 2001; Kyem 2004). For instance, different legal structures for copyright and traditions such as freedom of information access enable relatively easy diffusion of census data in countries such as the United States but constrict diffusion in Canada; this difficulty offers a prime reason why environmentalists' applications of GIS in Canada lag behind that of their American counterparts (Sieber 2003). Place determines the texture of social networks that exchange information and skills; it also governs more prosaic but still critical resources such as the extent of telecommunications and electrical infrastructure (Niles and Hanson 2001). Likewise, culture shapes PPGIS. de Man (2003), drawing on anthropology and organizational theory, proposes that information access as well as participation in decision making will differ according to factors such as a culture's ability to absorb uncertainty, its level of masculinity, and its ability to accommodate human inequality. Cultures can vary in their acceptance of PPGIS on the basis of their tolerance of expert solutions, their sense of collective control, and their level of individualism (Carver 2003). Therefore, a PPGIS application may be broadly accepted by all stakeholders in one community council meeting; the same application may utterly fail in another community because legal regimes restrict access to critical data, and culture and politics limit the type of participants to a specific gender, class, or caste.

Local influences may predominate so as to preclude PPGIS efforts from exerting any effect; occasionally the project may exacerbate existing tensions. Kyem (2001, 7) finds that, whereas PPGIS was judged by researchers to be a success in several villages in Ghana, "the marginalization and continued oppression of the people (i.e., curtailment of rights and deprivation of their access to resources) were achieved through the same institutions and structures which the . . . project [was] designed to transform." Hodgson and Schroeder (2002) describe a series of countermapping exercises among the Masai in Tanzania—"clarifying" village boundaries, classifying and dividing land uses into neat polygons—that disrupted traditional reciprocal relationships among communities. Not only can GIS be irrelevant, but its very benefits, such as improved visualization or data accuracy, can induce further injustice.

Scale and geographic extent are recognized as crucial elements in the context of PPGIS. Carver (2003) demonstrates that as cartographic scale increases, so does the intensity with which people connect with local issues. Scale may additionally refer to the organizational capacity to approach an issue (Elwood and Ghose 2001; de Man 2003) and thus mirrors concerns in political geography and anthropology. Problems such as a lack of affordable housing may manifest themselves at the local scale but, because they represent larger problems of race or class, require action at a broader scale. Indeed, the spatial extent chosen for the data and project may unduly bound its remedy (Aitken 2002; Stonich 2002). GIS resources may be exhausted in mapping at a neighborhood level so as to ineffectuate protest at smaller scales and greater extents. As PPGIS projects grow in number, more studies, particularly cross-comparisons, are needed to investigate scale effects in PPGIS.

Numerous articles demonstrate the importance of understanding how PPGIS is situationally and culturally influenced. However, to what degree is PPGIS completely contextually driven and therefore cannot be generalized? Specific factors, such as institutional culture, have been generalized to other geographies, organizations, and relationships. For example, Elwood and Ghose (2001) synthesize four factors that affect institutional culture in CBOs engaged in PPGIS: organizational knowledge and experience, networks of collaborative relationships, organizational stability, and organizational priorities, strategies, and status. Any framework, such as the one contained in this article, depends on a degree of generalizability. This remains a little acknowledged tension in PPGIS, the importance of particularity versus systematization, in which context can be analyzed separately. Certainly the addition of new disciplines, methods, and practices challenges the ability of PPGIS to be generalized.

Stakeholders and Other Actors. Precisely who should be participating in PPGIS projects? Schlossberg and Shuford (2005) note that the answers have eluded PPGIS as any exact delineation of relevant participants will be by definition exclusionary. To ensure sufficient inclusion, the authors define PPGIS participants as stakeholders who are affected by, bring knowledge or information to, and possess the power to influence a decision or program. Even with this expansive definition, Schlossberg and Shuford (2005) admit that important actors can be omitted; relevancy and availability can shift during various stages of the project; and chosen participants may reflect objectives of agencies and the agendas of other stakeholders. Thus, representatives of a disability rights organization may lack the physical stamina to participate throughout a process; in another instance, members of a CBO aligned with business interests may be invited to join. Notwithstanding a definitive list, project leaders must remain attentive to omissions, whether deliberate or accidental.

Delineation is further complicated by the potential of PPGIS initiatives to implicate stakeholders not in the immediate geography or those who operate at multiple scales. This opens intriguing possibilities for specific initiatives to include residents of other communities, government agency officials (e.g., data suppliers), NGOs, and even developers of the original software (Convis 2001; Sawicki and Peterman 2002). The Society for

Conservation GIS (SCGIS), an association of nonprofit conservation GIS users, has enabled international NGOs to find and strengthen not only the analytic capacity of local grassroots groups undertaking conservation (e.g., of tigers in Siberia and lemurs in Madagascar) but also strengthen their political clout (Convis 2001). The NGOs have become important actors in those local arenas. Conversely, broadening the scope to exogenous actors risks including those less committed to achieving the outcome; they face fewer consequences from proposed policies than those within the community or those more directly affected by the problems (Kyem 1998). In that sense, PPGIS practitioners have much to learn from their countermapping peers, who consider how extensively a project should be endogenously conceived and developed (Peluso 1995; McCall 2003).

Irrespective of the number and type of stakeholders, relationships among stakeholders will influence the outcome of a PPGIS project. Leitner et al. (2000) studied GIS-using CBOs in Minneapolis that had formed a dense network of relationships. Relationships among stakeholders in PPGIS activities ranged from cooperation, compliance, and collaboration to control. Categorization alone should not imply benefits. Sieber (1997) describes a conservation group that cooperated with state government and subsequently found itself shouldering the burden of disseminating the state's vegetation data. Uneven diffusion of GIS skills and technology among the stakeholders will likely place the less skilled at a disadvantage and therefore easier to control; however, numerous PPGIS examples indicate that powerlessness does not automatically correlate with lack of resources (e.g., see examples at http://www.scgis.org; Aberley 1993). The tendency in PPGIS is to view relationships as elastic; for example, the line between experts and locals can be quite thin and shift over time. Occasionally, PPGIS researchers and practitioners overestimate the mutability of relationships that, despite our best attempts, are rooted in roles ascribed to class, culture, and gender (Rocheleau, Thomas-Slayter, and Edmunds 1995; Kyem 2001).

The Public. This article separates the public from the stakeholders to reflect the original definition of PPGIS and because many applications continue to be developed for a general public. PPGIS encompasses numerous viewpoints so the public has been broadly characterized, for instance as neighborhood residents and members of marginalized communities, but also real estate agents and municipal government employees. This diversity generates lively discussions on, for example, what therefore constitutes a real PPGIS application (Tulloch 2003). Only recently has the discipline reflected the absence of a single public in PPGIS but instead multiple levels of public stemming from differing intensities of skills and attention (Schlossberg and Shuford 2005, 19).

Bosworth, Donovan, and Couey (2002) provide perhaps the best example of PPGIS approaches to engage different publics. They developed interfaces for five different publics to aid in accessing information about the city of Portland, Oregon. Each interface serves an increasingly complex application, from a digital gazetteer and a CD-thematic mapping package to spatial analysis software. The multiple interfaces illustrate a heterogeneous public that possesses differential levels of GIS and cartographic literacy. Technological adaptations tend toward supply-side approaches, which largely explain why the public is not more delineated in PPGIS.

Tackling the question of what constitutes the public in PPGIS becomes especially difficult with innovations, such as web-based PPGIS, that are designed to expand public outreach. Does someone who demonstrates interest in the project become a member of the public even though he or she is a continent removed from the community? It can be argued that, by definition, the public requires a physical bounding (e.g., a city or a neighborhood); however, different characteristics may complicate that identification (e.g., lifelong residents of the city vs. recent immigrants with strong ties to their countries of origin). Virtuality may have limited potential to build collective understanding and action, which may require a physical space (e.g., a meeting hall; Talen 2000; McCall 2003). Constituting the public and the geography it inhabits is further convoluted because the process of mapping can help legitimize the perceived composition of the community and those possessing the authority to impact decisions (Kosek 1998, 5). A PPGIS can empower a public at the same time it reifies a modifiable areal unit problem.

Technology and Data

The particularizing nature of PPGIS projects means that most individual researchers and practitioners concentrate on available equipment and specific data sets. Multiple perspectives call into question the extent of GIS needed to connote a PPGIS project as well as the technology's impact on projects. Researchers from disciplines of law, public administration, and geography and practitioners from local government have played significant roles in shaping how PPGIS considers not only the technology but the data, in terms of appropriateness and accuracy, access and ownership, and representation.

Extent of GIS Technology. As mentioned above, earliest participatory approaches using GIS tended to be materially expressed; that is, they focused on designing hardware and software and writing of training manuals and other documentation purposed for nonprofit organizations. Examples include Paint the Town™, a combination software package and drawing tablet, which allows users during public meetings to designate community land uses and draw urban growth boundaries; the software then forecasts households and jobs (Dieber 2003). The U.S. nonprofit Conservation Fund employed the Unified Modeling Language (UML) extension in ArcGIS™ to create a data model for land trust organizations (W. L. Allen and Christensen 2001). In both of these instances, technology in PPGIS is not regarded as a passive instrument, but instead represents a malleable tool that participants, provided they have a fairly high level of technical skills, can shift to suit their goals. The second example suggests that a number of nonprofit GIS users, particularly in conservation and public health, occasionally exceed the sophistication of applications from other stakeholders, including government agencies (Convis 2001; Schienke 2003).

At the other end of the technological learning curve, the IAPAD (Integrated Approaches to Participatory Development) group developed a process that blends GIS, physical models, and community participation into what they call "participatory three-dimensional modeling" (Rambaldi and Callosa 2000). GIS generates templates for constructing a cardboard model (one sheet of cardboard for each elevation contour line), which is detailed with pins (points), yarn (lines), and paint (areas). When finished, the model is gridded and photographed. The resulting photograph is digitized into the spatial database and overlain onto existing spatial data. Community members are not involved in the technical implementation of GIS, although they must learn basic cartography and the vector representations of points, lines, and areas. This is typical of many community mapping projects in which community members do not engage directly with the GIS but provide input and evaluate output (Al-Kodmany 2001).

The IAPAD project exemplifies an interface that is nontechnical. To increase an application's ease of use and lessen the need for GIS skills for participants, some PPGIS research and practice concentrate on enhancing the human-computer interaction (HCI) (Haklay and Tobón 2003). For example, Harris, Alagan, and Rouse (2002) produced a bird's-eye viewer for GIS for participants who experienced difficulty in comprehending their community from a two-dimensional planimetric map. Leitner et al. (2000) characterize HCIs from no direct use, to passive use, active use, and proactive use. These are not hierarchical; proactive is not necessarily the optimal level of usage. Nor will all stakeholders benefit equally. Particular stakeholders may benefit from the use of advanced technology. Others, for example, some elderly, may be marginalized.

Given an ever-broadening range of technologies, an effective PPGIS application depends on understanding how much and when technology should be brought into a process. The corollary is how much GIS must be learned by individual stakeholders and what technologies can be supported by available resources. Certain PPGIS activities may produce paper maps that participants simply annotate by hand. Most PPGIS activity is cartographic; that is, it focuses on the map as input and output, so map reading may be one essential skill. For others, computer programming on the part of the participants may be necessary.

Accessibility of Data. Whereas organizations may choose the appropriate level of technology for their project, many stakeholders lack access to the spatial data. Access to data has emerged as a growing area of concern in the PPGIS literature (e.g., *Urban and Regional Information Systems Association Journal* 2003, vol. 15, APA I, II).

As PPGIS has evolved, a divergence has emerged on how much access is necessary or even how access is defined. Access is variously defined as information about the policy-making process, acquisition of the raw digital data being used to craft that policy, the supply of public information, or the ability to submit information into official data sets (i.e., residents being solicited for information about their communities; Laituri 2003; Smith and Craglia 2003; Tulloch and Shapiro 2003). Tulloch and Shapiro draw the clearest distinction between types of access and characterize access as the fluid sharing of spatial data from data producers to likely participants in decision making.

Most spatial data available to PPGIS projects are created by the public sector. Drawing on the discipline of public administration, Hoffman (2003) summarizes the constraints placed on availability of this spatial data as a series of four competing ethics within government: (1) open government: information produced by the government is public and therefore should be inexpensive and easy to access; (2) individual privacy: privacy of citizens is paramount and data cannot be made public; (3) security: security of the state is a major factor and data that compromise that security cannot be made public; and (4) fiscal responsibility: government should be entrepreneurial in its approach to data that have a market value. Additionally, politics plays a role. Prior activities of grassroots groups may have sufficiently alienated data suppliers so as to preclude data access (Sieber 2000b). Government agencies, who would otherwise wish to disseminate spatial data, may be constrained by harsh political climates that limit dissemination to preferred stakeholders or may be restricted by cost recovery schemes that demand a return on GIS investments.

Even facilitators of public data access, such as universities or assisting nonprofit organizations, can face similar constraints (Sawicki and Craig 1996; Talen 2000; Haklay and Tobón 2003). University staff members, faculty, and students are not necessarily aware of many policies governing access to data, and in fact may be in violation of copyrights or licenses (van Loenen and Onsrud 2004). This may place university community partnerships in jeopardy as university students and faculty members disseminate data to community groups.

Appropriateness of Information. In PPGIS, the words *data*, *information*, and *knowledge* are frequently used interchangeably, although information here can be interpreted as data that are relevant and accessible for a particular objective. There are innumerable instances in PPGIS where data are available but exist in the wrong format, have incorrect resolution, or are incomplete. Chua and Wong (2002) found that when users of their community web site wanted spatial data (e.g., locations of street trees or housing conditions), users' needs were highly specific and were not met by available public records or administrative data, such as census and property tax data. Data that are important to social scientists, such as census socioeconomic and property tax data, may contain little significance to community groups (Sawicki and Peterman 2002). When a university, as a data intermediary, makes these data public the colloquialism usually ascribed to the process is to throw data over the wall. It is not always easy to ascertain the utility of specific data sets to an organization's or community's goals.

Barndt (2002) presents a model for assessing the value of primary and secondary data used in a PPGIS project. The model asks the following questions: Are the data and material produced appropriate to the organizational issues? Can the organization use the information in an action-oriented way to support decisions, enhance communication, and inform actions? Is information available to the organization in a timely manner? Is the information pertinent to organizational issues? Do the results have a temporal and cross-comparison component—that is, a time perspective? Although these are critical questions, they assume some degree of homogeneity or consensus around the definitions of terms such as "appropriate," "synergistic," or "accurate," a problematic assumption (Laituri 2003).

Barndt (2002) adds that, for data to be appropriate, one must assess whether the available data are sufficiently accurate. Accuracy represents an essential feature of data among many PPGIS practitioners, particularly those in the nonprofit sector (T. Allen, Morrison, and Swope 1998; Davis and Martin 1999; W. L. Allen and Christensen 2001). Data and analyses that are perceived to be accurate will likely determine organizations' ability to obtain grants and to influence policy. Although the drive for accuracy may be believed among PPGIS researchers to privilege expert knowledge over local knowledge, many grassroots groups proudly defend the science behind their data collection and analysis (Sieber 1997). Thus, the challenge in PPGIS is to understand the importance of accuracy and illuminate the assumptions underlying quantitative analysis.

Representation of Knowledge. Representation inhabits a contested position in PPGIS. Outside geography, most researchers and practitioners view representation to be synonymous with visualization. For those other fields, representation generally occurs only at the end of a PPGIS project and not at the beginning, such as when knowledge is categorized into variables. That view can be problematically narrow if one must then account for the role of the expert in portraying the public's perceptions of environment, the agenda of the nonprofit organization when presenting its analysis, or the intellectual property rights to that knowledge before and after it is transformed (Rundstrom 1995; Talen 2000). The actions of stakeholders may violate our own norms, for example, if tribal elders exclude women or youth from accessing certain types of spatial information. The countervailing position is to view representation as permeating every activity in GIS, which may essentially render the richness of the concept meaningless.

Representation is particularly cirtical where local knowledge is to be integrated. Researchers have attempted to incorporate local knowledge, also called indigenous technical knowledge or indigenous spatial knowledge, into the building of GIS databases. These efforts include value-based, traditionally intangible information, such as how residents value their homes or how they perceive the uniqueness of a given area (Rundstrom 1995; Craig and Elwood 1998; Elwood and Leitner 1998; Al-Kodmany 2001; Harris and Weiner 2002; McCall 2003). Numerous examples demonstrate that official data sets can be enriched with multimedia or local data sets (Harris and Weiner 1998; Engle 2001). Multimedia files can be attached as attributes to point layers to represent oral histories, nontraditional weighting schemes for site suitability can be evaluated, and language-specific user interfaces can be created. In turn, these approaches can be designed to give local residents greater access to the decision-making process. Al-Kodmany (2001, 2002) explores a variety of approaches to visualization and digital annotation of public comments and envisions a progression in which web-based GIS moves away from one-way information dissemination to two-way interactive communication to three-way public–public communication. In another example, Talen (2000) presents a model in which communication of local preferences can allow experts to translate environmental perceptions into GIS.

To ensure broad representation in these approaches, one must determine whose knowledge (expert/lay knowledge, men/women, rich/poor, young/old) should be included (Kyem 2001). How then is that knowledge transposed or made otherwise malleable for GIS? Is something ineluctable lost when the data are transformed? This is not to suggest that the goal of PPGIS is to convert all local knowledge into a digital product, "but to organise and present pertinent information that was not previously available, using the technological capability of GIS, to assist [groups] in their decision making" Jordan (1998, 8). In other words, not all traditional or local information should be reduced to fit GIS standards, but at the same time, the technology and its developers should bear responsibility to model information in a manner that the nonprofit organization or community with which they are working may find useful.

Process

Three main organizational processes have been considered in PPGIS: GIS implementation by grassroots organizations, participation in policymaking, and decision-making structures and management.

System Implementation and Sustainability. In this article, system implementation refers to the adoption of GIS technology by nonprofit organizations and less-resourced groups. This derives from work on GIS implementation in local governments in the United States, which has roots in organizational theory (e.g., see Nedovic-Budic 1998). "Implementation" is shorthand for the range of decisions made internally by an organization to acquire, install, implement, and maintain GIS, and direct its application toward the goal that drove the initial acquisition.

Even as costs for hardware and software decrease, costs for relevant and high-resolution data remain high. In developing countries, costs for all components tend toward the prohibitive and GIS expertise needed to maintain components may be remote. In the United States, grassroots groups and larger nonprofit organizations are largely able to implement GIS because they exist within a social network that supports their GIS activities. The network may include members of the public and private sectors, as well as university staff and private individuals (Sawicki and Craig 1996; Barndt 1998; Leitner et al. 2000; Sieber 2000b). A nonprofit intermediary sector has even emerged to assist the GIS needs of other nonprofit organizations and the public (Sawicki and Peterman 2002). A resource-poor grassroots group may be unable to afford GIS but can borrow a member's computer, install on it software donated by a vendor, acquire georegistered data from a university, receive GIS training from a technical assistance nonprofit organization, and print out a map on an E-sized plot supplied by a public agency.

However sympathetic the support networks, improvisation imposes its own costs, including the possible acquisition of inappropriate technology, a mismatch of skills and schedules, compliance with other institutions' regulations, or co-optation by other institutions' values. Resource-poor groups increase their likelihood of being co-opted as their organizational goals shift to those that fit with the goals of their funding agencies (Craig and Elwood 1998). For example, some GIS-using community development corporations were obliged to use HUD's Community 2020 software as a condition of access to financial support (Obermeyer 1998b), whether or not they possessed the capacity to use the software or required it for organizational goals. Most important, the support network is likely to be informal and fragile and fail to ensure long-term sustainability of the GIS.

Overall, PPGIS implementation can be differentiated by the level of coordination within an organization or network; the physical location of the hardware and software (e.g., in-house or outsourced); the availability of GIS technology, data, and expertise; objectives of the GIS; and the presence of a GIS champion who will shepherd the implementation process (Poole 1995; Leitner et al. 2000; Sieber 2000b). These different models of implementation not only categorize strategies of nonprofit organizations but also sharply divide the field. For example, PPGIS in development settings find many GIS resources external to the community and largely under the control of and administered by universities and public agencies. The challenge becomes one of external agents ensuring that project objectives match community goals and available resources. Among conservation nonprofit organizations, much of the effort is in-house. Implementation challenges resemble those of local government, although compared to government there are fewer resources and different project objectives.

Participation and Communication in the Policymaking Process. PPGIS relies on literature and practice that characterize public participation as a ladder of increasing involvement and influence in public policymaking (Arnstein 1969; Rocha 1997). According to a ladder model, participation in PPGIS can range from mere tokenism (e.g., the number of hits on a web-GIS site), to collaboration (e.g., meeting of stakeholders where GIS is used to identify conflicts), to some degree of citizen control (e.g., changes in local ordinances that benefit a specific neighborhood); see Heckman (1998), Carver (2003), Tulloch and Shapiro (2003), and Schlossberg and Shuford (2005). This work demonstrates that participation differs markedly depending on who defines it, at what level of spatial aggregation it operates, and what is the desired goal.

In a hierarchical model such as a ladder, the temptation is to assume that projects improve as participants ascend the ladder from community co-optation to community control. Kyem (2001) shows that, however much external agents may wish it, structures may not exist to support "high" levels of participation such as power sharing. In Kyem's Ghanaian examples, participation in PPGIS projects bestowed power on actors unprepared to use it, failed to attract people who may have benefited because of suspicion about another research project, operated in the formal administrative sphere but not the traditional tribal structure, enhanced disparities among villagers, and increased the chances for disputes. If PPGIS is to succeed in these instances, then structures must be built, or, at minimum, contexts must be acknowledged. Both need to be done at multiple scales.

Implementation of participation also may presuppose some degree of homogeneity of benefits among those involved in PPGIS. Certain individuals (e.g., rich, technically able, young) may be better able to participate than others (Craig and Elwood 1998; Carver et al. 2001). Craig and Elwood found that PPGIS activities could prove internally divisive if technically able members within CBOs felt more empowered than nontechnical members to influence policy. In other cases, widespread participation may not be desirable. Rundstrom (1995, 49) suggests that equal participation represents a Western fixation and that "indigenous rules about who should and should not receive geographic information is far from democratic." Models of participation should delineate the recourse for people who refuse to or cannot participate, and provide suggestions for what can be done if participation is ill-intended or destructive (Heckman 1998).

On that latter note, participation models by design do not include oppositional forms, such as protests or riots. Applications of GIS that, for example, contest the logging of forests or rally against expert-selected sites for affordable housing can greatly influence public policy but may still be labeled as illegitimate forms of participation (Convis 2001; Elwood and Ghose 2001). Enumerating steps in a ladder easily can reify what constitutes proper forms of participation; most models of PPGIS equate participation with some level of cooperation within existing government processes. Aitken and Michel (1995, 17) remind readers that "Participation in the creation of GIS knowledge does not necessarily give power to those involved in, and affected by decision-making." The inappropriate level of participation may disempower individuals, as mentioned above, and it also can distract groups from a desired outcome. To extend the logging example, instead of using GIS to determine where best to situate protesters to block logging activities, a grassroots group may be convinced to cooperate in a lengthy policy process that gives policymakers political cover for a forest to be cut down.

Finally, the eponymous incorporation of the word *participatory* is problematic because it necessitates a role for an intermediary. Someone, whether it is a developer writing a new user interface, a decision maker broadening the number of stakeholders, or an academic demonstrating the efficacy of new software, must open a process to participation. A bottom-up process may be preferred; the word *participatory* prescribes an element of top-down intercession. A truly bottom-up process likely will result in a definition of PPGIS that resembles the sociological. Academics and practitioners may be placed in an external position of critiquing the participatory GIS models employed by less powerful agents, instead of being granted a position to intercede on their behalf.

Decision-Making Structures and Processes. As noted in the social history of PPGIS, some actors identify PPGIS with "collaborative decision support." PPGIS has added value at several stages of the decision-making process, improving the articulation of stakeholders' views, increasing individuals' or groups' understanding of technology, making complex decisions more transparent and objective, augmenting deliberation and consensus, furthering communication and linkages among internal participants and between internal and external parties, disseminating or sharing information, resolving conflicts, and enabling greater exploration of ideas (Shiffer 1995; Kyem 1998; Elwood and Ghose 2001; Drew 2003).

Researchers and practitioners have tailored PPGIS to fit specific collaborative processes. Al-Kodmany (2002) describes one planning project in which an artist sketches citizens' perspectives on neighborhood redesign while the GIS of the area is displayed. According to Krygier (2002), these sketched graphics encourage greater participation because they are less polished, and the unfinished image suggests that issues remain undecided.

Drew (2003) implemented a spatial decision support system for the local public to express its views on the development of a nuclear power facility. This example demonstrates the importance of trust and transparency in crafting spatial decision support systems. It also illustrates how, instead of providing expanded control to the public, collaborative GIS applications may better serve the needs of the policymakers who operate within constrained mandates where developers cannot question either nuclear power as an appropriate power supply or the site selection. This example should not suggest that the use of PPGIS in nuclear power issues is inappropriate; instead, it shows that, irrespective of the technology, issues are framed to invoke certain questions, stakeholders, processes, and solutions.

Understanding the contribution of PPGIS in decision making can prove difficult. Drawing on decision support and behavioral science, Jankowski and Nyerges (2001, 2003) present a quantitative model for PPGIS to explicate the role of the decision-making structure in influencing outcomes and levels of participation. In particular, they highlight the role of culture on decision-making models. Respondents in Germany and Switzerland were much more amenable to decision models compared to respondents in the United States, who were distrustful of overtly constructed participatory models. Nevertheless, Jankowski and Nyerges and others in PPGIS believe that the dynamics of the process can be understood and generalized separate from the context that people bring into the process.

Questions remain on how best to integrate PPGIS into decision-making processes. What scale of decision making functions best with PPGIS—individual or collective (Leitner et al. 2000)? To better finance affordable housing projects, a local community development corporation may wish to jump scales and advocate at a more regional or national level, or scale up by joining with a better resourced organization. Roche (2003) points to the multiplicity and overlapping authorities (indeed, redundancies) of French governmental agencies which complicate an individual's ability to participate in decision making; primary decisions were made in intermunicipal organizations. By what means can nonspatial, nonquantified data be employed and how can conflicting data sets, analyses, and interpretations be resolved? At what stage in the decision-making process should the PPGIS be introduced? What decision outcome is desired (e.g., consensus, synthesis, or representation of multiple views)? Once again, questions of process must consider not just the process itself, but also the problem the process is designed to solve.

Outcomes and Evaluation

It is reasonable to assume, because this literature is named public participation GIS, that public participation is the stated endpoint of all PPGIS projects. However, as PPGIS has progressed into an expansive milieu of varied users and applications, this assumption frequently does not hold. Public participation may be neither the end nor the means by which the end is achieved. Should public participation be the stated goal, like many goals of PPGIS, it likely will pose a challenge to evaluation. Outcome and evaluation thus remain two of the least understood aspects of PPGIS.

Goals and Outcomes. The ostensible goal of PPGIS is empowerment. However, Heckman (1998) points out that in PPGIS the word is used haphazardly and its meaning is not universal. Instead, numerous outcomes and goals are reported across the breadth of the PPGIS literature. Outcomes range from the material, such as outputting maps and building three-dimensional physical models to the discursive. Discursive goals include empowerment, expanded participation, social capacity and inclusion, equity and redistribution, and increased democracy (Sieber 2000a; Craig, Harris, and Weiner 2002; Kyem 2004). These positive, and indeed positivist, goals must be balanced against potential negative consequences. Harris and Weiner (1998) make the substantial contribution that the outcome of a PPGIS endeavor can be the simultaneous empowerment and marginalization of a particular community or group. For example, building technological capacity in a CBO may allow that organization to advance its goal of creating a historic district. It also may elevate a skilled community resident's chance of obtaining a job outside the CBO and thus diminish the organization's new-found capacity.

Craig and Elwood (1998) classify the goals for the use of GIS by urban CBOs into four categories: administrative (e.g., locate members or activities), organizational (e.g., recruit members or obtain grants), tactical (e.g., search for suitable location), and strategic (e.g., evaluate success of activities). These functional categories mirror public and private sector goals, similar to increasing efficiency in tasks such as map production, reducing redundancy in databases, and improving effectiveness in decision making (Nedovic-Budic 1998). Contrasting these sectors, the goals of activists and members of marginalized communities can be far more intangible as well as more confrontational. Poole's (1995) account of the reasons for community mapping conducted by native peoples—including gaining recognition of land rights, protecting traditional land, gathering and guarding traditional knowledge, and achieving social justice—illustrates a more activist stance. Research in the environmental and conservation movements finds that functionalist goals fail to capture the passion felt by group members and underestimate the fervor employed to achieve those goals (e.g., deliberately endangering member's lives to save a tree stand or coastline—Sieber 1997; Stonich 2002).

Goals emanate from particular organizational cultures and personal ideologies (Elwood and Ghose 2001). An academic, for example, may be driven as much by the stated goals of a project as by his or her hopes for job retention, tenure, and promotion. A technocrat may wish to sideline certain stakeholders with excessive amounts of information or skill requirements to limit interference in an otherwise efficient decision-making process. Grassroots activists may express their goals through a culture of crisis and opposition. For a single PPGIS project, therefore, goals may be competing, contradictory, or less than altruistic. They may not be immediately apparent but instead may be ill-understood, unarticulated, or emergent during the process. Straightforward identification of goals is uncommon, and as Kim (1998, 11) notes, "[i]n a pluralistic society, with increasingly divergent viewpoints, it may be difficult to reach agreement over how GIS should be used and by whom." A CBO may simply want a researcher to produce a series of paper maps that show neighborhood conditions, which may conflict with the researcher's goal to build the GIS capacity of that CBO.

Measurement and Evaluation. Few PPGIS researchers explore measures of PPGIS effectiveness. Difficulties in measurement arise from the demands to establish a causal or associative relationship between technology and the outcome ascribed to it. A positive effect may be unconnected to PPGIS and instead reflect a well-connected and resourced organization.

PPGIS measures tend to match the goals in their level of abstraction. Barndt (2002) and others (Laituri 2003; McCall 2003) argue that the benchmark for a PPGIS project should be its appropriateness, that is, its match with an organization's existing activities, its adaptability to local conditions such as culture and climate, and its fitness to current organizational capacity and overall goals. Barndt (2002) adds that a PPGIS project should be integrated into broader societal goals, such as community development, sustainable development, and environmental preservation. Overall, relatively vague prescriptions of appropriateness and integration suggest a prime challenge in gauging PPGIS efforts. Heckman (1998, 19) notes that without a "clear definition (much less how to put such an idea or ideal into practice), public participation often serves as a proxy" for measuring PPGIS goals.

In her seminal work in the mainstream GIS implementation literature, Nedovic-Budic (1999) explains the difficulty of crafting explanatory measures. For instance, should they attempt to be tangible or intangible, measure internal versus external effects, be objective or perceptual, or assess qualitative or quantitative outcomes? Products such as maps can be counted; whereas satisfaction with decisions is far more qualitative and contingent. Moreover, evaluations must shift according to the stage of system implementation or organizational type. Six months into an implementation is likely an inappropriate time to measure the success of a PPGIS project; similarly, an all-volunteer staff should not be assessed according to the same standards applied to a paid, professional staff.

Few concrete measurement strategies guide PPGIS. Howard (1998) proposes a matrix of eleven types of participatory activities (e.g., involving participants in scenario planning) and seven applications of GIS (e.g., georeferenced audio recordings). He seeks an index of spatial empowerment through which spatial technology and participation techniques can best match the selected goal or outcome of a project. This matrix may offer an unnecessarily quantitative solution to assess what are intangible goals. However, PPGIS projects that focus on empowerment to the exclusion of immediate tangible benefits can fail unless the project is also targeted to urgent issues (Kyem 2001). Jordan (2002, 242) provides a list of social science methods for PPGIS; for example, to assess the attainment of long-term empowerment he recommends rapid rural appraisal, participatory rural appraisal, and other social science techniques. Others have called for a clearinghouse of proven tools and approaches (Kim 1998). PPGIS research has yet to establish either a set of best practices or a technique to demonstrate whether or not PPGIS is a suitable approach for a given problem.

Finally, it should be noted that the ability to assess the contribution of GIS to stated goals can predict the resources that will be available for and devoted to PPGIS projects. Conservation organizations, in particular, report direct correlations between their ability to prove that GIS is crucial to preserving the environment and their ability to obtain funding (Convis 2001). Despite the potential reduction of complex issues that occurs in quantifying intangible goals, funding agencies are increasingly demanding results that match the rhetoric of PPGIS (Silva, Saul, and Kim 2002).

Conclusion

PPGIS provides a unique approach for engaging the public in decision making through its goal to incorporate local knowledge, integrate and contextualize complex spatial information, allow participants to dynamically interact with input, analyze alternatives, and empower individuals and groups. The field continues to attract the attention of varied academic disciplines and sectors and across the spectrum of nonprofit organizations. To structure the broad range of activities in research and practice, the article first traced the social history of PPGIS, which courses through several disciplines and research and practice. It is through this collective exchange that the breadth of PPGIS is mutually constructed. To explicate the construction, the article then offered a framework of PPGIS consisting of four key themes: place and people, technology and data, process, and outcome and evaluation.

Overall the framework demonstrates that much remains to be understood in PPGIS, such as the generalizability of projects, the appropriate extent of technology, the nature of access and participation, and the concrete evaluation of PPGIS effects. Understanding scale effects is critical; much research and practice still occurs in single communities or with distinct nonprofit organizations. With few exceptions (e.g., Davis and Martin 1999; Sawicki and Peterman 2002), large-geographic scale or cross-comparative research has yet to be conducted. Larger studies are critically important as additional disciplines, such as public health, adopt and newly constitute PPGIS within their own disciplinary cultures. More important, researchers and practitioners must continue to reflect on their various roles in PPGIS because they are woven into the social network of assistance on which nonprofit organizations, especially grassroots organizations, depend.

As this field continues to evolve, innovations in technology and the ubiquity of GIS use for policymaking will challenge any framing of PPGIS. Web-based PPGIS projects test definitions of the public and understanding of the constituents of meaningful participation. The availability of spatial data and the utility provided by improvements in software and user interfaces, at least in the United States, suggest that policies can be determined remotely and obviate local context and participation. The ubiquity of GIS additionally implies that an era of dueling databases has begun, in which multiple stakeholders possess equivalent GIS capabilities. In that instance, PPGIS can further sideline those without access to or understanding of the technology. A full framing of PPGIS may include the most sophisticated applications; it also will need to encompass the paper map and pencil, coupled with meaningful participation that is fully cognizant of situational influences and diverse goals.

Notes

1. Variants on PPGIS include participatory geomatics or participatory geographic information technologies (participatory GIT), the latter to include GIS, GPS, remote sensing software, and spatial data.
2. I am grateful to Nicholas Chrisman and Francis Harvey for this formulation.

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