Public Participation GIS (PPGIS) for Regional and Environmental Planning: Reflections on a Decade of Empirical Research

Greg Brown

Abstract: *The term public participation geographic information system (PPGIS) was conceived to describe how GIS technology could support public participation with the goal of including local or marginalized populations in planning and decision processes. Based on experience with more than 15 PPGIS studies, the central thesis of this paper is that PPGIS has not substantively increased the level of public impact in decision making because of multiple social and institutional constraints. Following a review of a decade of empirical PPGIS research, this paper explores why government and nongovernment organization (NGO) adoption of PPGIS for environmental planning decision support has lagged. Despite methodological advances in PPGIS, agency barriers to effective public participation have not been fundamentally altered by PPGIS. For PPGIS to have a sustained impact on regional and environmental planning, agencies must meaningfully encourage and involve the public in planning processes irrespective of the GIS component.*

INTRODUCTION

This paper reflects on more than a decade of public participation geographic information systems (PPGISs) research in a range of regional and environmental applications in developed countries involving the general public as the key participant group. The central thesis is that while PPGIS aspires to improve the quality of decision making and increase the level of public impact beyond traditional stakeholder and interest groups, the fullest potential of PPGIS has yet to be realized because of a number of social and institutional constraints.

The term *public participation geographic information system (PPGIS)* was conceived in 1996 at the meeting of the National Center for Geographic Information and Analysis (NCGIA) in the United States to describe how GIS technology could support public participation for a variety of applications with the goal of inclusion and empowerment of marginalized populations. Since the 1990s, the range of PPGIS applications has been extensive, ranging from community and neighborhood planning to environmental and natural resource management to mapping traditional ecological knowledge of indigenous people (see Dunn 2007, Sieber 2006, Brown 2005, and Sawicki and Peterman 2002 for a review of PPGIS applications and methods).

The formal definition of the PPGIS remains nebulous (Tulloch 2007) with use of the term *PPGIS* emerging in the United States and developed-country contexts while the term *participatory GIS* or *PGIS* emerged from participatory planning approaches in rural areas of developing countries, the result of a spontaneous merger of Participatory Learning and Action (PLA) methods with geographic information technologies (Rambaldi et al. 2006). PGIS often is used to promote the goals of nongovernmental organizations, grassroots groups, and community-based organizations that may oppose official government policy, especially as pertaining to the rights of indigenous peoples and the current distribution of wealth and political power. In contrast, PPGISs may be sanctioned by government agencies, especially in Western democratic countries, as more effective means to engage in public participation and community consultation in land-use planning and decision making.

A concept related to PPGIS and PGIS, volunteered geographic information (VGI), is the harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals (Goodchild 2007). The review of PPGIS studies in this paper are distinguished from volunteered geographic information in that the spatial data-collection process is purposive and agency-driven rather than citizen-initiated and voluntary. Furthermore, the PPGIS methods described here contain probability sampling of the general public in combination with purposive and convenience sampling of stakeholders and interested observers. Although participatory GIS activity may involve community mapping and database development outside of formal government processes, the focus of this paper is on the genre of PPGIS research that seeks to expand and enhance public participation and community consultation in governmental processes for regional and environmental planning applications.

Regional and environmental planning processes in developed countries have historically been dominated by stakeholder and interest groups that are vested in planning outcomes. These planning processes can be highly technical in nature (e.g., public lands planning, town and regional planning, environmental planning) and may rely on technical assessments of land capacity and forecasts of probabilistic events. A persistent and important question for PPGIS is what can individuals possessing lay knowledge and understanding of place substantively contribute to the planning process? One possible answer is that PPGISs can provide understanding of place from the lived experience—a type of knowledge that is earned rather than learned. Local knowledge can provide a check and balance on expert and self interest–driven assumptions about planning outcomes.

The integration of lay knowledge from PPGIS in planning outcomes is a normative aspiration for deeper public participation and impact in the planning process. In terms of public participation impact identified by the International Association of Public Participation (http://www.iap2.org), collaboration or even empowerment, rather than involvement or consultation, would be the preferred public participation impact. An often unstated assumption is that the use of PPGIS will result in more socially equitable planning decisions. In developed countries, the social reform tenets of PPGIS are muted but not absent. The tenor of PPGIS in developed counties, as compared to PGIS is developing countries, is more aligned with reform and innovation of public participation processes rather than revolution in governance and land-tenure structure.

Following a review of PPGIS applications, this paper argues that despite methodological advances, PPGIS has yet to have a significant impact on regional and environmental planning outcomes. For PPGIS to have greater impact, agencies must be more committed to involving the public in planning processes irrespective of GIS.

PPGIS APPLICATIONS OVER THE PAST DECADE

The reflections in this paper derive from 17 PPGIS studies completed in the United States, Australia, and New Zealand between 1998 and 2011 (see Table 1). PPGIS studies were implemented for various regional and environmental planning applications, including national forest and national park planning, regional conservation planning, marine and coastal area conservation, urban park and open-space planning, tourism development, and scenic byway planning. All the PPGIS studies contained a random sample of the general public to identify the perceived location of spatial attributes such as landscape values, activities and experiences, development preferences, and special places. The type and number of spatial attributes collected were tailored to the planning purpose and geographic context of each PPGIS study. For example, planning for multiple-use lands such as national forests differs from planning for national parks or urban parks because of different legislative mandates. Table 2 provides a composite of spatial attribute definitions for landscape values, experiences, and development preferences that were used in multiple PPGIS studies.

Spatial Attributes

The list of spatial attributes participants were asked to identify in these and related PPGIS studies include landscape values and special places (Brown and Reed 2000, Brown et al., 2004, Brown 2005, Brown and Alessa 2005, Brown and Raymond 2007, Beverly et al. 2008, Alessa et al. 2008, Brown and Reed 2009, Clement and Cheng 2011, Zhu et al. 2010, Nielsen-Pincus 2011, Sherrouse et al. 2011, Brown and Weber, 2012b,), *development preferences* (Brown 2006, Nielsen et al. 2010, Brown and Weber, 2012c), *national park experiences and perceived environmental impacts* (Brown and Weber 2011, Brown et al. 2012), *climate change risks* (Raymond and Brown 2010), *transportation corridor qualities* (Brown 2003), *urban park and open space values* (Brown 2008, Tyrväinnen et al., 2007), *knowledge of landscape conditions* (Pocewicz et al. 2010), *recreation resources* (McIntyre et al. 2008), and *ecosystem services* (Brown, Montag, and Lyonet al. 2012, Sherrouse et al., 2011).

In the earliest PPGIS application for public lands, Brown and Reed (2000) asked randomly selected households in Alaska to identify the spatial location of landscape values such as aesthetic, recreation, economic, and ecological values, in addition to more indirect and symbolic landscape values such as spiritual and intrinsic values, as part of the Chugach National Forest (Alaska, USA) planning process. The guiding principle behind landscape-value mapping for public lands is that these lands should be managed for values that are consistent with values the public has for these lands. Although the quantity and mix of landscape values varies across landscapes, cultures, and countries, there is a core set of landscape values that apply to most public lands. What differs is the relative weighting and importance of values that the public holds for these lands. To illustrate, Figure 1 shows the collective distribution of landscape values, depicted as areas of high density in Prince William Sound (Alaska), from two different PPGIS studies completed in 1998 and 2000. The image displays the importance of the sampling approach in PPGIS as the spatial results vary significantly by community. Until the advent of PPGIS, there were few methods for agencies to spatially identify community values to assess the consistency of plan alternatives with regional and community values.

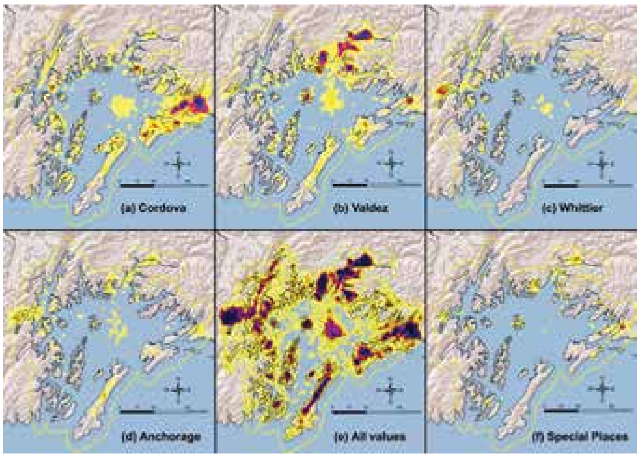

Figure 1. Spatial distribution of landscape values ("hotspots") by sampled community in the Chugach National Forest/Prince William Sound region in Alaska: (a) Cordova, (b) Valdez, (c) Whittier, (d) Anchorage, (e) all values in all communities, and (f) special places. "Hotspots" are higher densities or concentrations of point data within the PPGIS study region.

Table 1. List of PPGIS studies 1998–2011

Year	Implementation Mode	Location	Planning Purpose	Published References
2011	Internet (Google Maps)	Otago Region (New Zealand)	Regional conservation	Brown, G. In process. Website: http://www.landscapemap2.org/otago
2011	Internet (Google Maps)	Southland Region (New Zealand)	Regional conservation	Brown, G., and D. Weber. In review. Website: http://www.landscapemap2.org/nzdoc
2011	Internet (Google Maps and Google Earth)	South West Victoria (Australia)	Regional conservation and national park management	Brown, G., D. Weber, D. Zanon, and K. de Bie. In process. Website: http://www.landscapemap2.org/swparks3
2010	Internet (Google Maps)	Kangaroo Island (South Australia)	Tourism and conservation	Brown, G., and D. Weber. In process. Website: http://www.landscapemap2.org/kangaroo
2010	Internet (Google Maps)	Grand County (Colorado, U.S.)	Ecosystem service mapping	Brown, G., J. Montag, and K. Lyon. 2011. Website: http://www.landscapemap2.org/ecoservices
2009	Internet (Flash)	Alpine Region (Victoria, Australia)	National park planning	Brown, G., and D. Weber. 2011.
2007	Internet (Flash)	Mt. Hood National Forest (Oregon, U.S.)	National forest planning	Brown, G., and P. Reed. 2009. Website: http://www.landscapemap2.org/mthood
2007	Internet (Flash)	Deschutes/Ochoco National Forest (Oregon, U.S.)	National forest planning	Brown, G., and P. Reed. 2009. Website: http://www.landscapemap2.org/deschutes
2006	Internet (Flash)	Coconino National Forest (Arizona, U.S.)	National forest planning	Brown, G., and P. Reed. 2009. Website: http://www.landscapemap2.org/coconino
2006	Paper	Murray River, Victoria (Australia)	River conservation	Pfueller, S., X. Zhu, P. Whitelaw, and C. Winter. 2009.
2005	Paper	Otways Region, Victoria (Australia)	Tourism and conservation	Brown, G., and C. Raymond. 2006. Brown, G., and C. Raymond. 2007. Raymond, C., and G. Brown. 2007. Raymond, C., and G. Brown. 2006.
2004	Paper	Kangaroo Island (Australia)	Tourism and development planning	Brown, G. 2006.
2003	Paper	Anchorage Parks and Open Space (Alaska)	Urban park and open space planning	Brown, G. 2008.
2002	Paper	Kenai Peninsula (Alaska)	Coastal area management	Alessa, N., A. Kliskey, and G. Brown. 2008.
2001	Paper	Alaska Highways (Alaska)	Scenic byway nomination	Brown, G. 2003.
2000	Paper	Prince William Sound (Alaska)	Marine conservation	Brown, G., C. Smith, L. Alessa, and A. Kliskey. 2004.
1998	Paper	Chugach National Forest (Alaska)	National forest planning	Brown, G., and P. Reed. 2000. Reed, P., and G. Brown. 2003.

Table 2. A composite of selected spatial attribute definitions used in different PPGIS studies. The number and type of spatial attributes varied depending on the purpose and location of the PPGIS process. Other PPGIS spatial attributes not shown here include activities, highway qualities, urban park values, and ecosystem services.

Landscape values	Development Preferences	Experiences
Aesthetic/scenic—these areas are valuable because they contain attractive scenery including sights, smells, and sounds.	Tourism accommodation —this area is acceptable for building tourism accommodation such as hotels, motels, or lodges.	Aesthetic/scenic—I experienced pleasing sights, sounds, and/or smells.
Economic—these areas are valuable because they provide timber, fisheries, minerals, or tourism opportunities such as outfitting and guiding.	Tourism services—this area is acceptable for building tourism services such as restaurants, gas stations, or retail establishments.	Crowding/congestion—I experienced crowding with other visitors (e.g., the car park was full, I didn't find the right spot).
Recreation—these areas are valuable because they provide a place for my favorite outdoor recreation activities.	Urban development—this area is acceptable for new urban development (residential and commercial).	Solitude/escape—I experienced solitude, tranquility, and escape from social pressures.
Life sustaining—these areas are valuable because they help produce, preserve, clean, and renew air, soil, and water.	Rural residential development—this area is acceptable for rural residences with acreage.	Social interaction—I experienced positive social interaction with family, friends, or other visitors.
Learning/scientific—these areas are valuable because they provide places where we can learn about the environment through observation or study.	Industrial development—this area is acceptable for industrial development, including manufacturing, processing, or mining (e.g., gravel).	Trail-based activity—I experienced trail-based, physical, and/or adventure activity (e.g., bushwalking, mountain biking, cycling, jogging/running, cross-country skiing).
Biological—these areas are valuable because they provide a variety of fish, wildlife, plants, or other living organisms.	Wind-energy development—this area is acceptable for installing commercial wind turbines.	Other physical activity/adventure—I experienced other physical and/or adventure activity (e.g., canoeing, caving, swimming, exercising/fitness, fishing).
Spiritual—these areas are valuable because they are sacred, religious, or spiritually special places or because I feel reverence and respect for nature here.	Natural resource development—this area is acceptable for natural resource development such as gravel extraction, grazing, or forestry.	Overnight stay/camping—I experienced an overnight stay or camping.
Intrinsic—these areas are valuable in their own right, no matter what I or others think about them.	Energy development—this area is acceptable for energy development such as hydroelectric dams or wind turbines.	Learning/discovery—I experienced learning about nature, culture, or heritage.
Historic—these areas are valuable because they represent natural and human history that matters to me, others, or the nation.	Tourism development—this area is acceptable for building tourism accommodation and services.	Positive wildlife/vegetation experience—I had a positive experience with wildlife or vegetation.
Future—these areas are valuable because they allow future generations to know and experience the area as it is now.	Other development—this area is suitable for future development. Please click on the marker and write the type of development.	Noise—I experienced excessive noise (e.g., other people, aircraft, boats) here.
Subsistence—these areas are valuable because they provide necessary food and supplies to sustain my life.	No development—this area is perfect as is and should not have any new development of any kind.	
Therapeutic—these places are valuable because they make me feel better, physically and/or mentally.		
Cultural—these places are valuable because they allow me or others to continue and pass down the wisdom and knowledge, traditions, and way of life of ancestors.		
Wilderness—these places are valuable because they are wild, uninhabited, or relatively untouched by human activity.		
Marine—these areas are valuable because they support marine life.		
Social—these areas are valuable because they provide opportunities for social interaction.		
Special places—these places are special or valuable because...indicate your reason.		

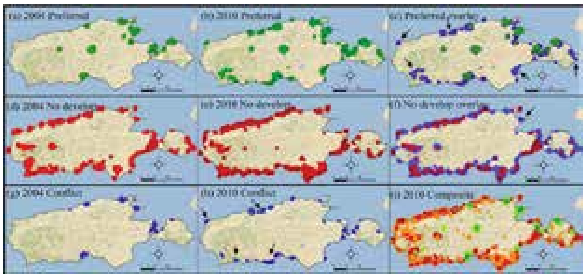

Figure 2. Preferred tourism development locations on Kangaroo Island (South Australia) measured using PPGIS: (a) in 2004, (b) in 2010, and (c) combined with blue areas indicating new locations in 2010. No development preferences: (d) in 2004, (e) in 2010, and (f) combined with blue areas showing changes. Locations of development preference conflict where tourism development hotspots are spatially coincident with no development hotspots: (g) in 2004, (h) in 2010. A composite 2010 map (i) showing development preferences ranging from positive (green to dark green) to negative (orange to red).

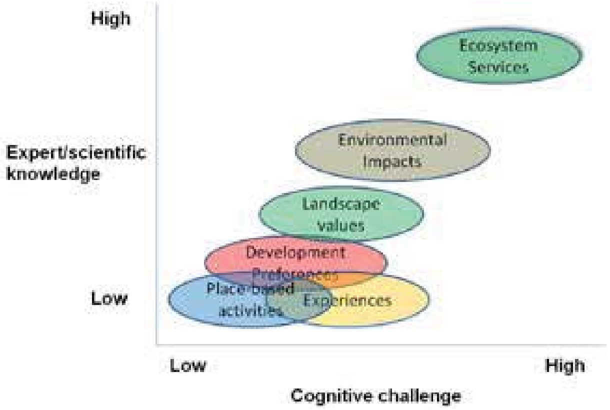

Figure 3. A conceptual map of the cognitive and knowledge requirements for identifying different PPGIS attributes

Development preferences appear relatively easy for PPGIS participants to identify and, arguably, have the closest nexus to potential land-use decisions. Development preferences can assess the general consistency of zoning classifications (Brown 2006) or more specific development proposals such as wind energy (Pocewicz et al. 2010). And yet, the identification of development preferences sponsored by local governments using PPGIS has been limited because public development preferences have strong implications for local land use including zoning and land-use controls. Figure 2 shows longitudinal tourism development preferences of Kangaroo Island (South Australia) residents generated from two PPGIS studies completed in 2004 and 2010. Kangaroo Island is an international tourism destination subject to tourism development pressure in ecologically sensitive areas. The image displays general consistency in resident preferences for the location of tourism development over time with residents preferring protection of the coastal areas and supporting tourism development in existing townships. In the 2004 PPGIS study, the South Australian Tourism Commission, a quasi-governmental tourism promotion agency, initially agreed to partner with the University of South Australia to provide financial support for the baseline PPGIS study of KI resident values. When the agency learned that the PPGIS process also would ask residents *where* tourism development was appropriate on the island, the agency withdrew support. PPGIS preference data appears threatening because of the potential to legitimize public opposition to development applications in a review process that has historically favored expert and insider access.

Participant mapping of spatial attributes in PPGIS can be plotted on two dimensions that display the degree of cognitive challenge or difficulty for the participant and the level of expertise or scientific knowledge required to spatially locate the attribute (see Figure 3). The relative positioning of the PPGIS attributes in the figure is based on this author's experience in implementing different PPGISs over the past decade. As illustrated in the figure, the mapping of ecosystem services in PPGIS represents the highest expert knowledge threshold and the greatest cognitive challenge thus far attempted in PPGIS. This is especially true for the spatial identification of "regulating" and "supporting" ecological services that require a minimum base-level knowledge about the functioning of natural systems in addition to familiarity with the regional landscape (Brown, Montag, and Lyon 2012). In contrast, participant identification of place-based activities, experiences, and development preferences represent low cognitive challenge and do not require a high level of technical expertise. These attributes are identified based on a participant's life experience living in or visiting the study region. The mapping of landscape values and perceived environmental impacts occupy the midrange of cognitive challenge and technical expertise. The identification of landscape values requires that the participant relate personal preferences to landscape features while the identification of perceived environmental impacts requires some understanding of changes to natural systems. The level of participation in PPGIS (i.e., response rate) can be influenced by the cognitive challenge and perceived level of expertise required, but most PPGIS studies include a mix of more and less challenging spatial attributes to map. The influence of cognitively challenging PPGIS attributes on response rates is most observable on a per-item basis and not generally reflected in overall participation rates that are subject to other larger, contextual variables that contribute to nonparticipation such as available time, Internet access, familiarity with the study region, and level of personal interest in the study content.

Mapping Methods

PPGIS data collection from the general public has been implemented using multiple spatial methods and technologies. For example, simple technology such as paper maps and markers (e.g., pencil, pen, stickers) were used in early PPGIS studies while digital mapping with markers using Internet PPGIS applications were implemented in more recent studies. Common to all types of PPGIS data capture is the need to symbolically represent the spatial attributes of interest on a map. Figure 4 shows four different

Figure 4. Four methods for collecting spatial information through PPGIS: (a) paper map and markers, (b) paper map and sticker dots, (c) Flash-based Internet application, and (d) Google Maps/Earth Internet application

methods for collecting spatial data using PPGIS. One conclusion about PPGIS data-collection methods is that the identification of spatial attributes by public participants with point rather than polygon features appears simpler and more effective but requires significantly greater sampling effort (Brown and Pullar 2012). A second conclusion is that simple PPGIS methods such as paper maps and markers may result in higher response rates, reduced participant bias, and greater mapping participation (Pocewicz et al. 2012).

Decision Support

In regional and environmental planning, the concept of place assumes central importance. Humans depend on, identify with, and become attached to places. Public participation processes have always elicited values about place, but these values have historically been measured indirectly and often in response to a proposed threat. In addition to measuring place attachment (Brown and Raymond 2007), the general social and perceptual attributes of landscape identified with PPGIS can be quantified into social landscape metrics (Brown and Reed, 2012) that assist with decision support through integration with other biophysical or administrative GIS data layers. Social landscape metrics measure the composition and configuration of human perceptions of landscapes and consist of two major types—*inductive* and *boundary* metrics. Inductive landscape metrics are the same as traditional landscape ecology metrics in their calculation and terminology with the key difference being that landscape "patches" consist of higher intensities of human perceptions and values rather than the presence of some biological or physical landscape features. Inductive patches emerge from the PPGIS data-collection and analysis process and may be described by their size, shape, and proximity to other patches. Boundary metrics are calculated based on the distribution of mapped PPGIS attributes that fall within predefined management areas of interest or spatial areas that have boundaries such as watersheds, political boundaries, administrative areas, or recreation sites. Boundary metrics include PPGIS attribute frequency, dominance, density, and diversity, as well as indices that measure conflict potential. Social landscape metrics may be useful in the planning and management of public lands such as national forests, parks, and resource-management areas because statutory requirements often dictate that these lands be managed for a range of public values and uses. Social landscape metrics identify and quantify the location of these values for comparative analysis and management.

PPGIS can be used to visually display the compatibility of proposed planning alternatives with the collective values held by different individuals and groups in society. Reed and Brown (2003) developed a quantitative modeling approach for PPGIS mapped-landscape values to determine whether forest plan activities and alternatives were generally consistent and, more important, place consistent with publicly held forest values. This decision support method was called "values-suitability analysis" because of its conceptual similarity to traditional physical land-suitability analysis. In a specific example of decision support, the place-specific compatibility of all-terrain vehicle use on a national forest in the United States was assessed based on PPGIS landscape values collected from a regional sample of random households (Brown and Reed, 2012).

For national park management, PPGIS has been used to generate indicators of social and ecological conditions such as crowding or trail conditions that provide thresholds for management action (Brown and Weber 2011). PPGIS also can be used to assess the consistency of visitor experiences and perceived environmental impacts within park management zones at the regional, national park unit, or subunit level.

The decision support potential of PPGIS for regional and environmental planning has been described in academic literature, and PPGIS has been presented to national forest and park planning personnel in particular, but there is little evidence of formal agency adoption beyond initial PPGIS trials. For PPGIS to play a significant role in agency decision support, it will need to become standardized into agency planning procedures.

THE NAGGING QUESTIONS

Who Is the "Public" in PPGIS?

Schlossberg and Shuford (2005) argue that the meaning of *public* and *participation* are essential to understanding the public participation component of PPGIS. In their typology, the term *public* may include decision makers, implementers, affected individuals, interested observers, or the random public. The latter classification—random public—appears most consistent with the more common dictionary definitions of public that include "all the people" or "people in general" (Merriam-Webster). And yet, PPGIS processes that systematically sample the general public are not common. Which "public" is represented in the PPGIS process? Is PPGIS just GIS with convenience sampling? Arguably, it is the public sampling and participation, not the GIS, that is the heart of PPGIS innovation.

The logic of collection action (Olsen 1971) ensures that vested interests in a planning process (i.e., the "affected individuals" and "interested observers") will participate to advocate their preferences in planning outcomes. These individuals and groups seldom need incentives to participate, although there may be differences in opinion about the mode of participation. What often are unknown are the values and preferences held by the "silent majority" or the "general public" who do not directly engage with a planning process. Outside the PPGIS studies cited in this paper, relatively little is known about this "public" component in PPGIS. Do the individuals and groups that traditionally participate in a planning process represent a broad range of social values and interests or more narrow self-interest?

The sampling approach that defines the meaning of "public" in PPGIS is the key determinant of the ability to claim social rationality in planning outcomes. The PPGIS studies described here contained a random, general public sample designed to elicit perspectives from all socioeconomic groups in society. But empirically, PPGIS responses from random samples of the general public contain bias toward greater male participation, higher average age, higher levels of formal education, and underrepresentation of racial-ethnic groups. These PPGIS results are consistent with survey research outcomes that lack special effort to recruit participation from lower socioeconomic groups and minority subpopulations. Sampling matters because the sociodemographic characteristics of respondents can influence the range of PPGIS attributes that are identified and mapped (Brown and Reed 2009).

PPGIS participants tend to be individuals with greater familiarity and experience with the planning area. This may be viewed as a positive bias because knowledge of the area results in a more accurate description of some place qualities. For example, self-selected PPGIS participants who were more familiar with study regions in New Zealand were more accurate in their identification of native vegetation than randomly selected regional households or visitors to the region (Brown, 2012). But familiarity bias in PPGIS can lead to the underrepresentation of values that individuals less familiar with place are likely to possess and express. For example, it is the symbolic, nonuse, and not directly familiar values for public land that can determine controversial public land outcomes such as protection of the Arctic National Wildlife Refuge (Alaska, United States) from oil and gas development.

The biased composition of PPGIS participants is a persistent critique that is difficult to rebut. And yet, PPGIS results are still likely to differ from outcomes advocated by interest groups and government agencies working without the benefit of PPGIS because the data are more socially inclusive, even if proportionately unrepresentative. For example, in the two Kangaroo Island (KI) tourism development PPGIS studies in 2004 and 2010, the results suggested greater public support for protection of the coastal zone from development than land-use controls contained in the KI Development Plan, the outcome of a more narrow public consultation process. But PPGIS results are rarely unequivocal as to proposed land use or allocation. A PPGIS process that includes the most expansive definition of "public" will generate results that reflect a broad range of perspectives. The complexity of social views about land use is mirrored in PPGIS results. If and when PPGIS methods become more widely accepted, the choice of "public" participants in PPGIS, especially with regard to development planning, will become a strongly contested arena.

Whose Interests Count More in PPGIS?

Critics of PPGIS may argue that decisions about public good often are national in scope while most implemented PPGIS systems have information collected from a regional population. Stakeholders in national, public lands should normatively include all citizens of the country. Local and regional populations, it is argued, are more vulnerable to "capture" by local economic development interests or may not fully appreciate the national importance of local landscapes. While this argument appears prima facie valid, there are practical resource limits for implementing national random-sampling methods using PPGIS. The PPGIS studies cited here used regional sampling of residents under the assumption that these people will be more familiar with the lands in questions and, arguably, have a greater direct stake in the outcome of the planning process. Consent of the regional population for planning outcomes appears a necessary (but insufficient) condition if future plan direction is not to be undermined. And yet, it is important to provide opportunities for nonregional participants and individuals not randomly selected to participate in the process.

All the PPGIS studies in Table 1 allowed participation regardless of geographic origin and regardless of whether an individual was randomly selected for participation. Responses from PPGIS "volunteers" are tracked and analyzed separately to compare with randomly sampled individuals. An ideal PPGIS process is one where random-sampling methods are used to generate the most objective spatial information possible, but where participation is encouraged from all segments of society. Empirically, participation in PPGIS processes from outside the planning area or from individuals not specifically invited to participate has been minimal because of, in part, a lack of awareness. Fears about local and regional populations not reflecting national interests in public land-planning outcomes appear overstated in practice, but the important question remains: Whose interests count most on the map and how does one aggregate spatial values and preferences equitably in PPGIS?

Participation: What If the Public Opts Out?

One of the strongest arguments in favor of PPGIS is that it expands the participatory process to individuals and groups who would not otherwise participate in the process. But what if these individuals are provided the opportunity but fail to participate? Internet-based PPGIS participation rates have averaged 13 percent across five studies (Beverly et al. 2008, Brown and Reed 2009, Brown et al. 2012), while paper-based PPGIS response rates have ranged from 15 percent to 47 percent, with an average of 30 percent across 11 surveys (Brown et al. 2004, Brown 2005, Alessa et al. 2008, Zhu et al. 2010, Clement and Cheng 2011, Nielsen-Pincus 2011, Raymond and Brown 2010). All modes of survey data collection show declining response rates (Couper and Miller 2008) and Internet-based surveys show 11 percent lower response rates (on average) than other survey modes (Manfreda et al. 2008).

Do low participation rates limit the usefulness of PPGIS methods? Yes and no. Participation rates that fall significantly below those reported for general survey results clearly threaten the external validity of the PPGIS results. Claims of representing the "public" are dubious with participation rates less than 20 percent. However, a typical regional PPGIS process will generate more than 200 responses, depending on the sampling effort, which far exceeds the number of individuals that would have participated in the planning process. Some participation bias will exist in respondent characteristics, but empirical evidence suggests this bias is not because of the content of the information being collected but rather is broadly attributable to other social factors that result in nonparticipation.

PPGIS methods compete with the many life demands placed on citizens of the world. And PPGIS methods are coming of age at a time when interest in nature and conservation, at least among the youth, is waning. Lack of participation should not necessarily be interpreted as lack of interest and apathy, but this may be a contributing factor. PPGIS may be a positive means to reconnect individuals to the places around them through maps and visualization, but the actual educational benefit of PPGIS participation is yet to be systematically assessed.

Virtually every PPGIS study has been challenged on the scope of participation and/or the participation rate and, consequently, the inferences about public support that can be legitimately claimed. Until PPGIS practitioners find ways to reverse declining social research participation trends, detractors of the method will be difficult to rebut based on the argument of social representation.

THE DEVIL YOU KNOW OR PPGIS?

While the potential of PPGIS to measure and integrate public values in regional and environmental planning outcomes appears promising, these aspirations have yet to materialize. Beierle (1999) suggests five social goals to evaluate the quality of public participation in environmental decision making. Does the process educate and inform the public? Incorporate public values into decision making? Improve the substantive quality of decisions? Increase trust in institutions? Reduce conflict? These are worthy goals but difficult to empirically assess without study beyond the PPGIS process itself.

The primary evaluation criterion guiding this paper is whether public values measured using PPGIS have been incorporated into regional or environmental decision making. This author has yet to observe any tangible evidence that PPGIS data has been used in agency decision making, let alone influence and improve the substantive quality of decisions in planning outcomes. The example of PPGIS for the Coconino National Forest in Arizona provides evidence for this conclusion. In 2006–2007, this author developed and implemented a PPGIS process for the Coconino National Forest to evaluate the effectiveness of Internet-based PPGIS. The resulting PPGIS dataset contained more than 8,000 observations of forest values and special places provided by Arizona residents. Following PPGIS data collection, the author traveled to Arizona to brief the forest's planning and management teams on the PPGIS results and to present the forest with the actual PPGIS data. After several years of delay in the forest plan revision process, the author reminded the forest planning staff about the PPGIS data that was collected for the forest planning process. The forest management team had either lost or forgotten (or both) the PPGIS dataset. As of the writing of this manuscript, the PPGIS data have yet to be even acknowledged as part of the public record for the Coconino planning process.

To date, PPGIS has been promoted more by academics than it has by government agencies or NGOs. There are a variety of explanations and many are related to the reasons why government agencies are reluctant to engage in broader, more inclusive public participation in general.

Lack of Specific Directives/Incentives to Engage the Public

Bureaucrats do not get rewarded for innovation or taking risks with new participatory methods. Just the opposite. There are career risks for engaging new methods, especially ones that are untested, and few tangible rewards if the new methods prove effective. The use of PPGIS for environmental planning requires inside bureaucratic champions (early adopters) who are institutionally rare. Nonetheless, some progressive individuals were identified to sponsor the PPGIS studies shown in Table 1 and include the U.S. Forest Service, Parks Victoria (Australia), and the New Zealand Department of Conservation. But the identification and recruitment of bureaucratic innovators remain significant barriers to more widespread agency adoption.

Fear of the General Public

Does engaging the general public through PPGIS tap into the "wisdom of the crowds" or the "tyranny of the masses"? For some, the people, the masses, are unpredictable, unstable, and can be mobilized into revolutionary action. Political leaders can lose their figurative heads in the ensuing planning debate. Both political and bureaucratic leaders will naturally seek to avoid any situation in which the masses are presented with an opportunity to express doubt about their leadership.

Lack of Experience

Never attribute to malice what can otherwise be attributed to incompetence or inexperience. The Coconino National Forest's handling of the PPGIS data, described previously, illustrates this principle. Government agencies lack experience in innovative and nonlegalistic public participation techniques. Many simply do not know how to effectively engage and manage the public in planning processes. Public participation often is contracted out to consultants who have the experience, but this has the effect of placing an intermediary between the people and the agency, which increases distrust in the planning authority.

Expert-Lay Divide

Agencies house experts in particular disciplines associated with environmental planning and management. Many of these individuals believe that they did not spend significant time and effort to obtain their technical expertise and qualifications only to abdicate responsibility to those less formally educated in the discipline. Agencies believe they have the necessary expertise to make sound technical decisions and they do not believe public consultation will substantively improve the knowledge base for decisions.

Regulatory Barriers to Public Participation

For agencies in the United States, legislation prohibits federal government information collection without review and approval by the Office of Management and Budget (OMB). This regulatory requirement, which can take well over a year to obtain approval (if at all), effectively thwarts agencies from engaging in broad participatory processes that involve PPGIS data collection even if an agency is predisposed to the concept of PPGIS. For example, the U.S. Forest Service has formally requested to use PPGIS to assist national forest planning but has been denied by the OMB for more than three years (P. Reed, personal communication).

These reasons provide strong disincentives for government agencies to engage in participatory processes that would include PPGIS. Even if agencies recognize the deficiencies and limitations of prevailing public participation methods, it is more comfortable to work with a known system.

Government agencies are not the only ones reluctant to engage PPGIS methods and distrust of the public is not limited to government agencies. Resistance to use of PPGIS has come from unexpected sources. There was an expectation that environmental stakeholders and NGOs would embrace the use of PPGIS in public land-planning processes because the identification of place-based conservation values is a likely, but not guaranteed, outcome of a PPGIS process. But in practice, the opposite has occurred. Generally speaking, environmental stakeholders do not trust PPGIS. Why? Environmental stakeholders and NGOs trust in their ability to influence the public land-planning process from the inside through pressure politics and their own technical expertise. Although not always successful, they have learned how to exert political pressure at the appropriate time to ensure conservation outcomes. For them, PPGIS is a wild card for which they have little control over the outcome. They fear the PPGIS process can be "gamed" in ways in which they are unfamiliar and unprepared. NGOs have become quite adept at influencing public planning processes, and even though the outcomes are not always ones they would prefer, they would rather live with the political devil they know than with PPGIS.

Industry stakeholders share a similar level of distrust as do environmental NGOs. PPGIS is too new for them to feel comfortable with the method. They would prefer to keep the number of actors in a planning process small and manageable. Like their environmental adversaries, they do not trust a process that could result in outcomes unfavorable to their interests. Both environmental and industry stakeholders have the ability to orchestrate "public" support for particular planning outcomes. They would prefer a process where they can *manage* "public opinion" rather than having an agency *measure* public preferences through PPGIS.

In summary, there is no strong support from within government to expand public participation through PPGIS, and there is active resistance from some traditional stakeholder and interest groups. And yet, the use of PPGIS is likely to increase given the irresistible pull of new technology and the Internet.

MAPPING THE FUTURE OF PPGIS

The slow adoption of PPGIS methods by agencies for regional and environmental planning does not appear technological but may reflect a lack of government commitment to public participation and consultation in general. The lack of familiarity with PPGIS as a new consultation methodology and concerns with the accuracy and validity of lay knowledge in environmental decision processes serve to reinforce a propensity toward agency inertia. The lack of standardized methods and models for both collecting and integrating PPGIS data into decision processes—the knowledge integration problem—add additional resistance to PPGIS adoption. And yet, mapping technology is a compelling and powerful force that is not easily dismissed.

The explosion in Internet mapping applications and virtual earth models has created an environment that should be favorable to the expansion of PPGIS. But GIS technological innovation has outpaced understanding of human factors resulting in suboptimal implementation of mapping technology for PPGIS. For example, in a recent Web-based PPGIS application for Parks Victoria (Australia), we provided an integrated Google Maps and Google Earth application interface that allowed participants the opportunity to examine and map any attribute in the study area. The application contained the zoom features of Google Maps and the three-dimensional visualization of Google Earth and provided the participant with the ability to seamlessly switch between map modes. But few PPGIS participants actually used these advanced navigational and visualization features; the majority of participants choose to identify the spatial attributes at the default map scale that provided insufficient map resolution for placing the spatial attributes within the requested national park boundaries. When the application was modified to enforce a minimum map scale for marker placement, participants responded by placing fewer markers. Thus, the most effective means for increasing PPGIS participation while maintaining spatial data quality remains a work in progress.

Using incentives such as prize drawings or "lotteries" to increase general public participation has had limited effect with the PPGIS studies described here. This result is consistent with the extensive survey research literature on lottery incentives indicating little or no impact on survey response (see, e.g., Singer, van Hoewyk, and Maher 2000; Warriner et al. 1996). Prevailing upon planning stakeholder groups to encourage their constituents to participate can increase the rate of volunteer participation, but this does not increase the participation rate of the general public that provides important baseline, comparative data. A PPGIS implemented for Parks Victoria evaluated the use of an opt-in Internet panel maintained by a leading survey research organization in Australia as a potential pathway to increase public participation; participants were rewarded for PPGIS completion and the number of completions increased, but the overall quality of the PPGIS data based on mapping effort was poor (Brown et al. in process).

Thus, we are left with the current paradox of PPGIS applications: Despite the proliferation of Internet mapping technology, there has not been a commensurate increase in PPGIS participation rates. In fact, the opposite may be true. With greater saturation of Internet mapping applications, the novelty and potential attractiveness of participating in an Internet-based PPGIS may decline. There is no magic formula for increasing PPGIS participation that also maintains data quality. Agency appeals through advertising such as that used by the New Zealand Department of Conservation (see Figure 5) offer potential to increase participation, but the actual effectiveness of mass media advertising for PPGIS currently is unknown.

The initial reluctance of conservation NGOs to engage in PPGIS may be waning. The recent PPGIS study by the Nature Conservancy in Wyoming (Pocewicz et al. 2010) suggests the method may be gaining some favor as a means to indirectly promote the mission of the NGO and to increase public awareness about important land-use issues. In the United States, because federal agencies are constrained in their ability to conduct PPGIS because of OMB regulatory review, NGOs may play an important partnering role with agencies in collecting PPGIS data.

Although PPGIS methods for regional and environmental planning now are more than a decade old, the planning and decision impact, thus far, has been limited. PPGIS will not fix fundamentally flawed participatory processes that are superficial, obligatory, or token. For PPGIS to have a sustained impact on regional and environmental planning, agencies must meaningfully encourage and engage the public in planning processes irrespective of the GIS component.

Figure 5. Image of promotional message prepared for the New Zealand Department of Conservation PPGIS study for the Southland and Otago Regions in support of regional conservation planning effort

About the Author

Greg Brown is an associate professor of environmental planning at the School of Geography, Planning and Management, University of Queensland, Brisbane, Australia, and a research associate at Central Washington University, Ellensburg, Washington, and Green Mountain College, Poultney, Vermont.

Corresponding Address:
School of Geography, Planning and Management
University of Queensland
Brisbane, QLD 4072, Australia
Greg.brown@uq.edu.au

References

Alessa, L., A. Kliskey, and G. Brown, 2008, Social-ecological Hotspots Mapping: A Spatial Approach for Identifying Coupled Social-ecological Space, Landscape and Urban Planning, 85(1), 27-39.

Beverly, J., K. Uto, J. Wilkes, and P. Bothwell, 2008, Assessing Spatial Attributes of Forest Landscape Values: An Internet-based Participatory Mapping Approach, Canadian Journal of Forest Research, 38(2), 289-303.

Beierle, T. (1999). Using Social Goals to Evaluate Public Participation in Environmental Decisions, Policy Studies Review, 16, 75–103.

Brown, G. and L.Brabyn. 2012. The extrapolation of social landscape values to a national level in New Zealand using landscape character classification. Applied Geography 35(1–2):84–94.

Brown, G., 2012. An empirical evaluation of the spatial accuracy of public participation GIS (PPGIS) data, Applied Geography 34: 289-294. DOI:10.1016/j.apgeog.2011.12.004

Brown, G., D. Weber, D. Zanon, and K. de Bie. 2012. Evaluation of an online (opt-in) panel for public participation geographic information systems (PPGIS) surveys. International Journal of Public Opinion Research. DOI:10.1093/ijpor/eds001

Brown, G. and D. Weber. 2012a. A place-based approach to conservation management using public participation GIS (PPGIS). Journal of Environmental Planning and Management http://www.tandfonline.com/loi/cjep20.

Brown, G., and D. Weber. 2012b. Measuring change in place values using public participation GIS (PPGIS). Applied Geography, 34: 316–324.

Brown, G., and D. Weber. 2012c. Using public participation GIS (PPGIS) on the Geoweb to monitor tourism development preferences. Journal of Sustainable Tourism. http://dx.doi.org/10.1080/09669582.2012.693501.

Brown, G., and P. Reed. 2011. Values Compatibility Analysis: Integrating public values in a forest planning decision support system. Applied Spatial Analysis and Policy. DOI:10.1007/s12061-011-9072-x

Brown, G., and D. Pullar. 2012. An evaluation of the use of points versus polygons in Public Participation Geographic Information Systems (PPGIS) using quasi-experimental design and Monte Carlo simulation. International Journal of Geographical Information Science. 26(2):231-246.

Brown, G., J. Montag, and K. Lyon, 2012. Public Participation GIS: A Method for Identifying Ecosystem Services. Society & Natural Resources. 25(7): 633-651. .

Brown, G., and P. Reed. 2012. Social landscape metrics: Measures for understanding place values from Public Participation Geographic Information Systems (PPGIS). Landscape Research. 37(1): 73-90.

Brown, G. and D. Weber, 2011, Public Participation GIS: A New Method for Use in National Park Planning. Landscape and Urban Planning, 102(1), 1-15.

Brown, G. and P. Reed, 2009, Public Participation GIS: A New Method for National Forest Planning. Forest Science, 55(2), 166-182.

Brown, G. 2008, A Theory of Urban Park Geography. Journal of Leisure Research, 40(4), 589-607.

Brown, G. and C. Raymond, 2007, The Relationship between Place Attachment and Landscape Values: Toward Mapping Place Attachment, Applied Geography, 27(2), 89-111.

Brown, G., 2006, Mapping Landscape Values and Development Preferences: A Method for Tourism and Residential Development Planning, International Journal of Tourism Research, 8(2), 101-113.

Brown, G., 2005, Mapping Spatial Attributes in Survey Research for Natural Resource Management: Methods and Applications, Society & Natural Resources, 18(1), 1-23.

Brown, G. and L. Alessa, 2005, A GIS-based Inductive Study of Wilderness Values, International Journal of Wilderness, 11(1), 14-18.

Brown, G., C. Smith, L. Alessa, and A. Kliskey, 2004, A Comparison of Perceptions of Biological Value with Scientific Assessment of Biological Importance, Applied Geography, 24(2), 161-180.

Brown, G. 2003, A Method for Assessing Highway Qualities to Integrate Values in Highway Planning, Journal of Transport Geography, 11(4), 271-283.

Brown, G. and P. Reed, 2000, Validation of a Forest Values Typology for Use in National Forest Planning, Forest Science, 46 (2), 240-247.

Clement, J. and A. Cheng, 2010, Using Analyses of Public Value Orientations, Attitudes and Preferences to Inform National Forest Planning in Colorado and Wyoming, Applied Geography, 31, 393-400.

Couper, M.P., and P.V. Miller, 2008, Web Survey Methods, Public Opinion Quarterly, 72(5), 831–835.

Dunn, C.E., 2007, Participatory GIS – A People's GIS? Progress in Human Geography 31(5), 616–637.

Goodchild, M., 2007, Citizens as Voluntary Sensors: Spatial Data Infrastructure in the World of Web 2.0., International Journal of Spatial Data Infrastructures Research, 2, 24-32.

Manfreda, K.L., M. Bosnjak, J. Berzelak, I. Haas, and V. Vehovar, 2008, Web Surveys Versus other Survey Modes, International Journal of Market Research, 50(1), 79-104.

McIntyre, N., J. Moore, and M. Yuan, 2008, A Place-based, Values-centered Approach to Managing Recreation on Canadian Crown Lands. Society & Natural Resources, 21(8), 657-670.

Nielsen-Pincus, M., C.S. Goldberg, A. Pocewicz, J.E. Force, L.P. Waits, P. Morgan, and L. Vierling, 2010, Predicted Effects of Residential Development on a Northern Idaho Landscape under Alternative Growth Management and Land Protection Policies, Landscape and Urban Planning, 94(3), 255-263.

Nielsen-Pincus, M. 2011. Mapping a Values Typology in Three Counties of the Interior Northwest, USA: Scale, Geographic Associations among Values, and the Use of Intensity Weights, Society & Natural Resources, 24(6), 535-552.

Olson, M., 1971, The Logic of Collective Action: Public Goods and the Theory of Groups (Cambridge: Harvard University Press).

Pfueller, S., X. Zhu, P. Whitelaw, and C. Winter, 2009. Spatial Mapping of Community Values for Tourism Planning and Conservation in the Murray River Reserves, Victoria, Australia, (Gold Coast: CRC for Sustainable Tourism). Available at http://www.crctourism.com.au (accessed May 2011).

Pocewicz, A., Nielsen-Pincus,M., Brown, G., and R. Schnitzer. 2012. An evaluation of internet versus paper-based methods for Public Participation Geographic Information Systems (PPGIS). Transactions in GIS 16(1):39–53.

Pocewicz, A., Schnitzer, R., and M. Nielsen-Pincus, 2010. The social geography of southern Wyoming: important places, development, and natural resource management, The Nature Conservancy, Lander, WY, 16 pp. Available from: http://www.nature.org/wyoscience [Accessed 28 December 2010].

Rambaldi G., A.P. Kyem Kwaku, P. Mbile, M. McCall, and D.Weiner, 2006, Participatory Spatial Information Management and Communication in Developing Countries, EJISDC, 25, 1. http://www.ejisdc.org/ojs/include/getdoc.php?id=246&article=263&mode=pdf

Raymond, C. and G. Brown, 2007, A Spatial Method for Assessing Resident and Visitor Attitudes Toward Tourism Growth and Development, Journal of Sustainable Tourism, 15(5), 520-540.

Raymond, C., and G. Brown, 2010, Assessing Spatial Associations Between Perceptions of Landscape Value and Climate Change Risk for Use in Climate Change Planning. Climatic Change, 104(3), 653-678.

Sawicki, D.S., and D. R. Peterman, 2002. Surveying the Extent of PPGIS Practice in the United States. In W.J. Craig, T.M. Harris, and D.M. Weiner (Eds.), Community Participation and Geographic Information Systems, (London: Taylor & Francis), 17-36.

Schlossberg, M., and E. Shuford, 2005, Delineating 'Public' and 'Participation' in PPGIS. Journal of the Urban and Regional Information Systems Association, 16, 15–26.

Sherrouse, B.C., J.M. Clement, and D.J. Semmens, 2011, A GIS application for assessing, mapping, and quantifying the social values of ecosystem services, Applied Geography, 31(2), 748-760.

Sieber, R., 2006, Public Participation Geographic Information Systems: A Literature Review and Framework, Annals of the Association of American Geographers, 96(3), 491-507.

Singer, E., J. van Hoewyk, and M. Maher, M, 2000, Experiments with Incentives in Telephone Surveys., Public Opinion Quarterly, 64: 171–188.

Tulloch, D., 2008, Is VGI Participation? From Vernal Pools to Video Games, GeoJounal, 72, 161–171.

Tulloch, D., 2007, Public Participation GIS (PPGIS). In Encyclopedia of Geographic Information Science, SAGE Publications. Available from: http://www.sage-ereference.com/geoinfoscience/Article_n165.html (Accessed May 2011).

Tyrväinnen, L., K. Mäkinen, and J. Schipperijn, 2007, Tools for Mapping Social Values of Urban Woodlands and Other Green Areas, Landscape and Urban Planning, 79, 5-19.

Warriner, K., J. Goyder, H. Gjertsen, P. Hohner, and K. McSpurren, 1996, Charities, no; Lotteries, no; Cash, yes: Main effects and Interactions in a Canadian Incentives Experiment, Public Opinion Quarterly, 60, 542–562.

Zhu, X., S. Pfueller, and P. Whitelaw, 2010, Spatial Differentiation of Landscape Values in the Murray River Region of Victoria, Australia, Environmental Management, 45(5), 896-911.