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Participatory Geographic Information Systems (PGIS) in Visual Research

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INTRODUCTION

In the digital age, interactive maps have become ubiquitous parts of our phones, automobiles, cameras, and hiking gear. Whereas maps were once the result of highly specialized and privileged procedures implemented by professional cartographers, and were instruments which wielded control and power (see also Innisfree McKinnon (Chapter 24), in this volume), they are now available to anyone with a computer hooked to the Internet. But with the increased use of digital mapping programs, new questions are being raised about access and interpretation. As visual researchers, we wonder how the widespread availability of tools that link data with maps that visually display information contribute to visual research?

One of the most compelling features of digital mapping tools is their potential to correlate and display text, images, and numbers within visually accessible data displays linked to physical space. In addition, digital maps may be scaled, altered, and shared. They have potential as tools that help visual researchers build a spatial context around what might otherwise appear to be unrelated or disparate localized data.

The attraction of digital mapping instruments for visual research is tied to the fusing of two key elements: spatial representation of a range of data and robust computerized databases, which may include numeric, text, audio, visual or other types of digital data. A web-mapping application, such as the 'Map', 'Satellite', and 'Earth' views provided by Google Maps (see http://maps.google.com), gives every point on a digital map the potential to be linked to varieties of additional data. Images and other kinds of digital data may be bound together in scalable structures that encourage connections, correlations, and broad distribution.

Geographic information systems (GIS) help manage all this data. While we commonly think of these as sophisticated digital systems, approaches to collecting and

managing geographical data have long been in use, and there are a number of companies producing such systems today. ESRI, for example, accounts for a large share of the GIS software market worldwide. ESRI defines GIS as:

> A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.
>
> GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.
>
> A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared (ESRI, 2010).

Computerized mapping tools can give a GIS visual power: maps can be drawn from the database, or alternately, data can be referenced from maps. When a database is updated, an associated map can be updated as well. Still, even a sophisticated GIS is only as good as the data it contains. While there is no denying the potential power of a GIS for integrating many kinds of data into a coherent visual system, a promising alternative to systems designed for the use of specialists is the evolution of participatory methods known generally as public participation GIS (PPGIS) or participatory GIS (PGIS in this chapter) projects that are meant to promote community self-advocacy and local control, as well as to encourage knowledge production and access for community members by providing access to data and tools once considered unavailable to local organizations (Al-Kodmany, 2002; Knigge and Cope, 2006; Sieber, 2006).

In the following sections, I briefly review GIS and mapping in general and introduce a number of strategies for using maps in the humanities and social sciences. I also describe developments in participatory GIS, and discuss benefits of incorporating PGIS approaches in social research projects, where community members are given access to planning processes as well as to emerging and powerful mapping tools; I then present examples of PGIS projects developed for a variety of purposes. These summaries are intended to introduce readers to projects involving PGIS to demonstrate the broad potential for increasing community participation in data management and decision making.

As a deeper illustration of the power of PGIS, I share a case study describing my own work on the development of a PGIS system which employed a cultural studies approach to supplement the planning needs of the San Miguel watershed in southwest Colorado (Collins, 2009); I added to the conversation by layering local cultural practices on existing maps. The project strategy was designed to utilize the very instruments that reside at the core of many local planning processes – in this case, county GIS maps – to engage local residents in mapping the culture of that geolocated place. Using county maps as a base layer, I created additional layers tied to the underlying geographic locations of artifacts, including historic photographs, photographs and art work by local residents, as well as oral history and interviews with members of the community. Rather than excluding the local, personalized and subjective aspects of the experiences of individuals and communities, the use of a GIS in participatory decision making and land-use planning processes was supplemented by the addition of visual techniques to highlight important cultural practices.

VIEWS OF MAPS AND MAPPING PROCESSES

We go about our daily business, as individuals and as members of various communities, in the spaces that are the raw material for maps. And, we may transform those geolocated *spaces*, through our own actions and interactions, into *places* of community. Cartography can represent space by literally reflecting 'the lay of the land'. Until recently,

most significant mapping efforts were directed by dominant institutions and groups that defined, researched, and/or managed spatial contexts, and their outputs became expressions of institutional power and control of knowledge (Harley, 1989; Crampton, 2001; Kitchen and Dodge, 2007). Consider, for example, the development of the 'grid' system typically used in many US cities in the planning process. This system, the Public Land Survey System (PLSS), was originally conceived by Thomas Jefferson:

> … shortly after the Revolutionary War, when the Federal government became responsible for large areas west of the thirteen original colonies. The government wished both to distribute land to Revolutionary War soldiers in reward for their service, as well as to sell land as a way of raising money for the nation. Before this could happen, the land needed to be surveyed.
>
> The Land Ordinance of 1785 which provided for the systematic survey and monumentation of public domain lands, and the Northwest Ordinance of 1787 which established a rectangular survey system designed to facilitate the transfer of Federal lands to private citizens, were the beginning of the PLSS (NationalAtlas.gov, 2010).

This system is still in use today and has been applied to purposes far beyond its original design: for example, in planning, land management, or energy policy. These data are also available for public download (see http://www.blm.gov/wo/st/en/prog/more/gcdb.html).

Modern maps that are considered authoritative documents – especially those used for planning, navigation, resource allocation, etc. – are typically the result of huge amounts of processed data such as this, derived from large-scale data-gathering instruments and procedures including satellite-born cameras, political polling, voter registration, tax records, census data, property values, environmental assessment reports, crime statistics, and the like (Dorling et al., 2006). Data collected in this way are stored in large databases, and tied to physical spaces as geographically referenced datapoints. Referred to as 'geocoding', this process matches up the attribute data to a 'basemap', which allows it to be displayed in visual form (Jardine and Teodorescu, 2003). As GIS data have been increasingly linked to sophisticated but readily available mapping software, much of the analysis is output directly in the form of maps and map-layers. This allows users to visualize patterns and relationships from the beginning of the research process; it has also led to a blurring of the distinction of a GIS as solely the underlying raw data, and many now use the terms 'GIS' and 'computer mapping' interchangeably (Jardine and Teodorescu, 2003: 6).

Large GIS's are often managed by a variety of agencies, both public and private, for an increasing number of applications in government, education, and industry, and increasingly in public/private partnerships (Ghose, 2007: 1961). Other well-known and publicly-available examples (to name but a few) are

- the *US Census* (http://factfinder.census.gov/home/saff/main.html?_lang=en)
- the *CIA Factbook* (https://www.cia.gov/library/publications/the-world-factbook/index.html)
- the *UN Environment Programme* (UNEP, see http://geodata.grid.unep.ch/).

In commercial use, the Multiple Listing Service (MLS) in the USA now links geographic information to real estate sales information and public records, to provide agents, buyers, sellers, and financiers with a full picture of property history and transaction information (DeLorme, 2010). More commonly, anyone can 'Google' a street address and discover satellite photos, topographic features, or directions for walkers, bicyclists, drivers, or those taking public transport.

The use of GIS applications by government agencies to map social (or anti-social) behaviors continues to be a largely centralized enterprise, and conclusions based on such data sources are often guided by post-positivist and reductionist views on the nature of what constitutes reality. For example, historical data on burglaries committed in an area may also be tagged with data such as day, time, location, frequency, and even weather, and used to generate predictions on

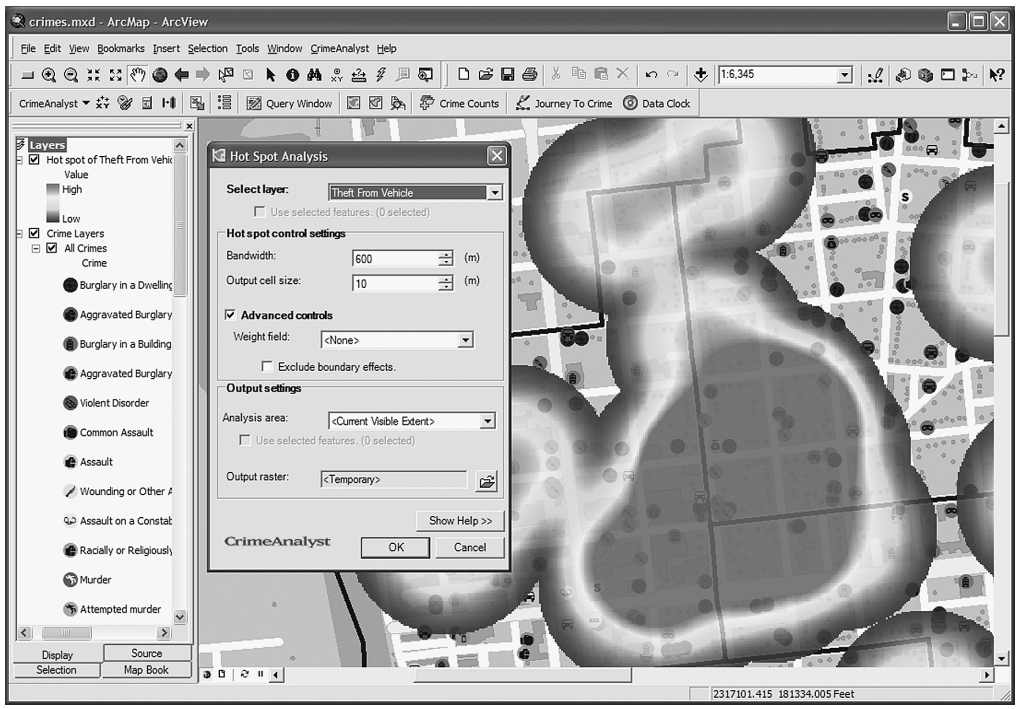


Figure 25.1 Fear of crime. Using so-called 'hot spot mapping,' this GIS software helps to identify and analyze high-risk areas

Source: http://www.geo-comm.com/geolynx_crimeanalyst.html

the probability of future burglaries in a neighborhood, and public safety resources allocated accordingly (Steinberg and Steinberg, 2006).

In addition to its use in localized planning and decision making, a GIS can be a useful tool for qualitative research and inductive theory building. Knigge and Cope (2006) made the case for creating locally-*grounded* explanations that aid theory building, by combining 'everyday experiences and actions' with 'data about the social world'. They commented:

> Displaying quantitative spatial data in a variety of ways may reveal patterns, and statistical analysis may reveal correlations, but it is often the case that explanation (and thus theory building) is grounded in the experiences of real people living through specific conditions and they are in many ways the 'experts', even if their explanations seem to be at odds with other sources of data (2028).

Articulating alternatives to traditional centralized approaches, Steinberg and Steinberg (2006) argued that spatial information provided by GIS can also be employed in more inductive approaches to research. Patterns visible in spatial data can be powerful aids in developing theory when exploring emergent themes drawn from existing social data (78–94). They outlined strategies for integrating spatial concepts into social science research and pointed out that GIS provides a wide range of opportunities for examining relationships in space, often by focusing on information not traditionally considered:

> Because a GIS can integrate data from a variety of sources, it allows the researcher to develop a

> holistic view of the many different contextual variables that may be important in addressing a particular social issue or research question (37).

In the case of mapping incidents of crime (mentioned earlier), for example, a map-making process that integrates multiple vectors – demographic data, income, environmental factors, education *and* crime statistics – may be more useful in long-term efforts to eradicate crime. If the goal is to actually improve the conditions on the ground, map-making efforts should not simply be a catalog of spatial/temporal incidents. Armed with a range of 'contextual variables', it may be possible to identify root causes rather than to simply visualize symptoms (Steinberg and Steinberg, 2006).

Maps are also increasingly being seen to represent socially constructed views of *place* (Crampton, 2001; Kwan, 2002). In his seminal essay (Crampton, 2001: 240) on critical mapping, Harley (1989) pointed out that, whatever else they are, maps are never value neutral; they are active agents that can help to preserve the status quo or catalyze change (14). In a book review in the *Annals of the Association of American Geographers*, Aberley and Herlihy (1994) noted:

> As most geographers today are quick to acknowledge, 'map power' has long been controlled by the dominant societies of the world who portray and interpret cartographic information in terms of their own privileged perspectives, often for their own economic gain. Geographers are equally aware that indigenous peoples' oral, action-based knowledge of the environment is seldom represented in these dominant forms of mapping (n.p.).

A number of theorists have discussed embedded ideologies inherent in maps, or as Harley referred to them, the 'second text within the map' (1989: 9), and have shown how maps may misrepresent, distort, or even deliberately skew representations of reality through decisions made and techniques used by map makers (Wood, 1992; Dodge and Kitchin, 2000 n.p.; Kwan, 2002; Pickles, 2004; Dorling et al., 2006). For example, the choice of method used to produce a flattened representation of three-dimensional (3-D) space, known as a map projection, will result in certain predictable visual distortions. The projection of a global map that most of us are familiar with is the Mercator projection of longitude and latitude; the resulting representation displays India as a much smaller land mass than Greenland, while in physical reality, it is seven times larger (Dorling, 2007: 0013). Dorling pointed out that, when applied to analysis of global disease:

> The world distribution of malaria shown on a conventional map gives the impression that the global distribution of clinical episodes of Plasmodium falciparum malaria is confined to a much smaller proportion of the earth's surface than is actually the case (0013).

And users, too, will filter messages portrayed by a map and draw conclusions based on their own frames of reference (Becker, 2007: 93–94). 'The power of maps is diffuse, reliant on actors embedded in contexts to mobilise their potential effects' (7); in increasingly pluralist societies, geographic information and mapping can help communities coalesce by delivering useful and usable data, informing both human and spatial relations (Craig and Elwood, 1998; Al-Kodmany, 2002). Mapping this data and visualizing these relations can also add form to individual and collective realities, and stimulate interest in further investigation (Aberley, 1993). Indeed, geosocial visualizations can incorporate diverse cultural, political, ideological, class, or gender views that may act as counter-narratives to those produced by centralized and powerful political or scientific organizations (Kwan, 2002). Approached as place-based technologies with a strong participatory component, digital maps may be used to foster a shared sense of place among people, improving programs and outcomes by encouraging cooperative problem-solving.

PARTICIPATORY GIS (PGIS)

Encouraging public participation by providing access to localized data and encouraging cooperative planning processes have not been actively pursued until recently:

> Increasingly, urban planning activities in the United States are undertaken through a local governance model in which public/private collaborative partnerships are prioritized and the rhetoric of citizen participation is strongly echoed.… [T]o facilitate this… a range of 'public participation GIS' (PPGIS) initiatives have taken place, providing grassroots, inner-city neighborhood-based citizen groups (hence forth called 'community organisations') with equitable access to spatial data and GIS-based analysis (Ghose, 2007: 1961).

There are compelling reasons to consider PGIS approaches as alternatives to traditional institutional planning based on depersonalized and summarized data leading to generalized conclusions. Feminist GIS researchers, for example, have taken issue with positivist approaches that ignore subjective differences related to culture or gender, stripped of locally-situated experience (Kwan, 2002: 646–648). Kwan also noted:

> the representational possibilities of GIS can be used for enacting creative discursive tactics that disrupt the dualist understanding of geographical methods where visual images, words, and numbers are used together to compose contextualized cartographic narratives in geographical discourse (2002b: 272, as cited in Knigge and Cope, 2006: 2023).

PGIS methods can provide various opportunities for engaging communities in decision making. Among the benefits provided by a PGIS project are:

1 Incorporating community-based knowledge as data.
2 Integrating and contextualizing complex local spatial information.
3 Allowing participants to dynamically interact with input, and to analyze alternatives.
4 Empowering individuals and groups to pursue joint knowledge production and improve community access.

A key objective of PGIS approaches is the empowerment and inclusion of marginalized populations – those with little voice in the public arena (Sieber, 2006; Ghose, 2007). At Oregon State University, Professor Dawn Wright directed a group of graduate students in an advanced GIS program to create a community-focused PGIS website in the fall of 2007 (see http://kilumijimforest.wordpress.com/about-us/ for more on this project). The focus was to provide a platform for collaborative efforts directed toward forest conservation of an important bird habitat in Cameroon, bringing together the local community and conservation groups. Through this work, the *Public Participatory GIS for The Kilum-Ijim Community Forest Project (Kilum-Ijim Forest Project)*, they found that when given the opportunity, community members could be directly involved in many aspects of the PGIS process, including the production of sketch maps, physical models, digital maps, databases, and other spatial and visual tools. Their focus was to promote networking with existing programs and agencies who could provide access to pertinent available data, technical skills, and financial or educational resources. The project successfully led to the development of a sophisticated PGIS user community who could help foster awareness of available technical resources previously unknown (Kilum-Ijim Forest Project, 2007).

PGIS researchers can rely on spatial data that they collect or create themselves, or they may use publicly accessible data or some combination of the two. The last two decades have led to a significant increase in the availability of public data, including those mentioned earlier, as well as more at local levels, through clearinghouses and web-based services, a process Tulloch (2007) described as *Democratization*. In this way, a PGIS has the potential to encompass a vast range of visual, qualitative and quantitative data available to build foundations of knowledge for bridging gaps and misunderstandings between social scientists and the individuals and communities with which they work.

Whereas some PGIS developers seek to empower individuals, others may be managed by groups intending to shift power in their favor (Sieber, 2006; Tulloch, 2007). Ghose (2007) discussed issues relating to the need for effective network formation to address issues of imbalances in scales of power:

> Network formation at multiple scales, with powerful actors located in public and private sectors, is crucial for grassroots community organizations in their urban revitalization activities, as they occupy a subordinate position in terms of political and economic hierarchies…. [because] scalar politics can enable one to control material resources and can legitimize one's own viewpoint and agenda over that of others (Ghose, 2007: 1962; citing Kurtz, 2002).

PGIS, then, is not so easy to pin down; rather, the methods, tools, and intentions of a project, including the nature and degree of actual community involvement, will depend on a project's context, the project goals, resource availability, degree of cultural acceptance at the local level, etc. The conversation around attempts to define what PGIS is or isn't 'is being mutually constituted, locally and philosophically' (Sieber, 2006: 492–494).

EXAMPLES OF PGIS

In the paragraphs that follow I present brief, suggestive but not exhaustive, examples of PGIS programs. They range from a slightly less conventional 'pin in the map' way to convert crime data into a visual/spatial representation, to more innovative collaborations between artists and policymakers. No technological development is, by itself, empowering. Clearly, all PGIS projects are not 'bottom-up' ways of empowering individuals or communities; some may be simply sophisticated manipulations 'buying' compliance. On the other hand, there are interesting examples of public involvement in decision making in which map making is a helpful and perhaps necessary step. There are also object lessons where the best laid plans of researchers and communities are simply overridden by policymakers with agendas of their own. Another developing model is 'hybrid' PGIS in which participatory elements in a public planning process are integrated into a more traditional and authoritative presentation 'owned' by bureaucratic institutions. These brief examples were influential in my own project design process.

City of Bradford, UK: Fear of crime

A group of urban geographers at the University of Leeds set about to map the *fuzziness* associated with the *fear of crime* (see Figure 25.2). By 'fuzziness' the authors were referring to what they called 'vernacular geography', which they defined as having some or all of the following characteristics:

1. Continuousness: when boundaries are difficult to define because the measurements of an entity produce a gradient (the start of a mountain, for example).
2. Aggregation in the categorization of variables: where discrete boundaries actually represent the average location of a geographically varying set of continuous or discrete variables that are binned together for descriptive convenience (soil types, for example).
3. Averaging: where discrete boundaries are actually an average of time or scale, varying geographical boundaries (the definition of a col, the boundary of a river, etc.).
4. Ambiguity: where boundaries are tied to linguistic factors (for example, 'high' crime areas) (Waters and Evans, 2003: n.p.).

Using maps to track something as intangible as fear required some innovative techniques. Areas associated with crime are not necessarily bounded by identifiable landscape, but they are usually diffuse and have different levels of intensity depending on the individual. The researchers settled upon the metaphor of the *spray can* as an appropriate tool to *tag* those areas in the neighborhoods that individuals associated with high levels of

crime (Waters and Evans, 2003). Local users in the City of Bradford, UK were asked to 'spray' a map to indicate areas where they felt there was a 'fear of crime.' This input was translated into a series of 'density maps' that were correlated with particular neighborhoods and actual crimes (Waters and Evans, 2005: slide 20).

South Africa: Post-apartheid land reform

David Weiner and Trevor Harris (2003) collaborated with a rural South African community to capture local knowledge of perceived landscape boundaries in GIS format. They examined the role that GIS played in how people viewed, exploited, and managed their physical resource base. The research included not only PGIS techniques but also implementation of a community-integrated GIS. Weiner and Harris emphasized non-hegemonic ways of knowing and provided conceptual and methodological guidance for integrating local community knowledge with geospatial technologies. While their work provided a useful roadmap to others interested in applying PGIS techniques, they highlighted the point that impacting local policy was difficult to sustain, in their experience, because of personnel changes and shifting national policies in post-apartheid South Africa. To be blunt, the good wishes and research processes of social scientists and community members may be overridden by policymakers – no

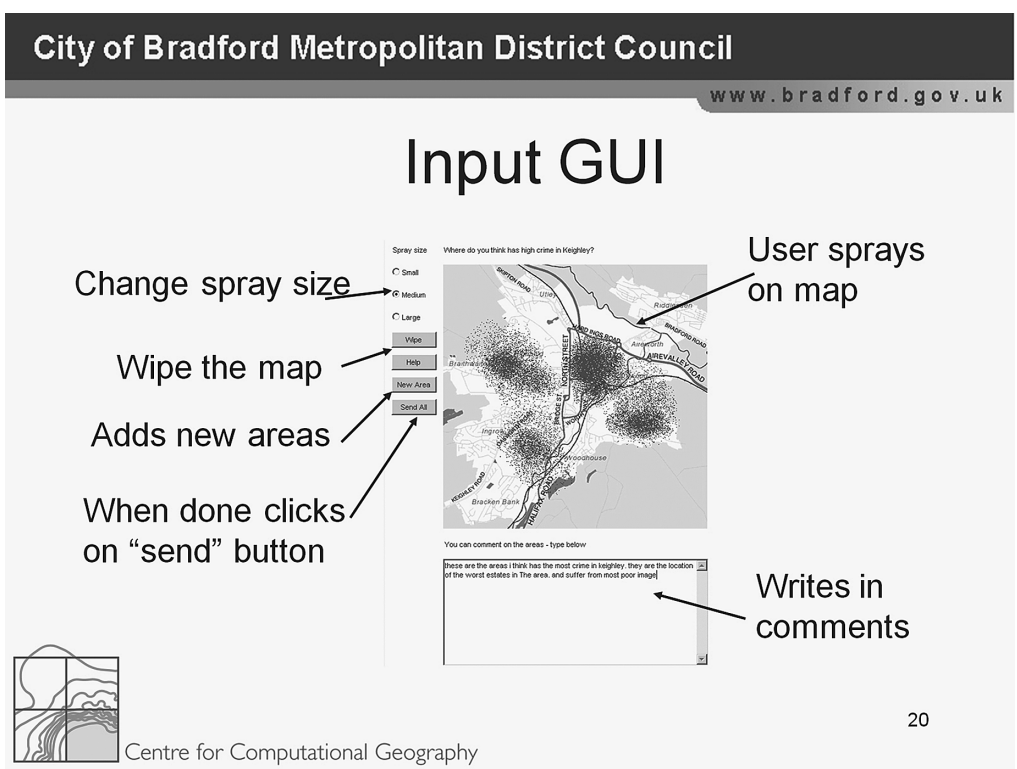


Figure 25.2 Fear of crime. In this graphical user interface (GUI), local users in the City of Bradford, UK 'spray' a map to indicate areas where there is a 'fear of crime.' This input is translated into a series of 'density maps' that can be correlated with particular neighborhoods and actual crimes (Waters and Evans, 2005, slide 20)

matter what technologies are employed (Weiner and Harris, 2003).

Chicago, Illinois: Neighborhood planning and the arts

In his study, 'GIS and the artist: Shaping the image of a neighborhood in participatory environmental design,' Kheir Al-Kodmany (2002) used geospatial technology, in conjunction with a graphic artist, to help a local Chicago neighborhood group to work cooperatively with public officials to improve neighborhood safety. Al-Kodmany reported on ways that a GIS and an artist played interdependent roles in a community planning process. The GIS provided community leaders, planners, architects and designers with an interactive visual representation of the neighborhood as a *space*, and helped to create sample design prototypes in relation to their geographic context. The artist, on the other hand, translated neighborhood residents' ideas of the neighborhood as a *place*, with ascribed social meanings, into quick sketches, merging their ideas and thoughts into a shared neighborhood vision. Together, the GIS and the artist provided ways for residents to visualize past, present, and future neighborhood conditions, and enabled them to express a greater voice in the design of their neighborhood. Al-Kodmany defined public participation as a key component of environmental planning and design. He also pointed out, however, that planners and designers may not be equipped with tools or techniques needed to achieve meaningful public collaboration. The study reinforced the view that being able to visualize architectural and social change is a key component in public participation.

Neighborhood revitalization

Sarah Elwood and Helga Leitner (2003) critically examined the role of geographic information systems used by neighborhood organizations in planning and revitalization efforts in US inner cities. They argued that the use of GIS is related to marked changes in the roles and responsibilities of neighborhood organizations and is part of a neoliberal policy agenda that expects them to play an increasing role in neighborhood revitalization. Drawing upon research about neighborhood organizations in Milwaukee, Minneapolis, and St. Paul, the team showed how the spatial knowledge and revitalization strategies produced by these organizations frequently reflect and reinforce those promoted by the state. In other words, they also caution that all so-called 'bottom-up' strategies are not necessarily empowering but may instead be ways of producing compliance. At the same time, they observed that some neighborhood organizations construct alternative knowledge through their use of GIS and employed alternative visions of neighborhood revitalization as they navigated the tensions between community visions and state priorities (Elwood and Leitner, 2003).

Aboriginal mapping

'First Nations' in British Columbia (BC) and elsewhere in Canada have been using GIS to manage land and resources and other traditional perspectives on *place*. Two 'First Nations' tribes, the Squamish and the Lil'wat, based north of Vancouver, BC, have utilized GIS for their tribal needs and applications. During a conference focusing on Native American traditions and GIS mapping, Chrystal Nahanee of the Squamish Nation provided details on the process they followed for adopting GIS to meet tribal needs, and she discussed projects to develop comprehensive parcel maps, emergency planning, and resource maps with up-to-date land cover data. Tracy Howlett of the Lil'wat Nation described participatory mapping exercises for developing traditional lands inventory and parcel maps. Both speakers emphasized the importance of *growing* the

technology from within the tribes, without the use of external consultants; for example, Howlett described ways that using 3-D maps helped achieve visual understanding of digital data by community members. Another tribal representative described the Aboriginal Mapping Network (AMN, 2009), a website that provided the ability to network indigenous communities that are otherwise professionally and geographically isolated. Using the website, participants were able to share best practices, leading to development of an interactive online GIS toolkit (Laituri, 2006: n.p.).

HYBRID FORMS OF GIS/PGIS

Though the history of GIS is still in process, with the development of new user-friendly applications for PGIS, improvements in communications technology, and the near-universal accessibility of the Internet (through public institutions if not at home), it is now reasonable to assume that a significant population of users can participate in studies seeking *community-grounded* data for GIS mapping projects. In many recent mapping projects a hybrid approach has been used. Large-scale (macro-level) data is combined with fine-grain (local-level) data collected via participatory processes. For example, the US Bureau of Land Management (BLM) in Southwestern Colorado (Montrose Office) has worked on including social and economic information into their GIS mapping strategies when evaluating the biophysical processes on a landscape. By soliciting input from local citizens, the BLM planned to build maps that would provide a deeper understanding of how the general public interacts with public lands.

Rather than following a participatory model, however, the data from this participatory GIS mapping exercise is expected to 'be integrated into a more "top-down" mapping model (SIMPPLLE) developed by the US Forest Service (Maggie McCaffey, Montrose Interagency Fire Education Specialist, personal communication).'[1]

Another example of a hybrid GIS mapping project that combined 'top-down' and 'bottom-up' approaches is a 2005 study conducted at MIT. Richardson and Peyser (2006) used a multi-layered GIS mapping system to develop a 12-part conservation strategy for the lesser prairie chicken. In the course of their research they proposed three key principles:

- First, the trustworthiness of the data – e.g. layers of land classifications, land ownership, grazing leases, and oil and gas development information that the stakeholders believed to be true.
- Secondly, the transparency of the system – the graphic images were easy to read, the ways the data were combined and manipulated were understandable.
- Thirdly, the accessibility of the system – participants could debate and adjust key parameters, including habitat quality boundaries and land classifications.

The authors emphasized the importance of including 'non-science perspectives' and 'on-the-ground knowledge':

> Early on, stakeholders expressed different perspectives about the causes of the decline in the habitat and the species. These perspectives were particularly related to the Prairie-chicken habitat characteristics, impacts from oil and gas development, and the natural and human caused reasons for decline in good habitat (e.g. drought vs. development and human encroachment). Some felt it particularly important to incorporate 'on-the-ground' knowledge and cutting edge research, while others felt strongly that decision-making should include only the best scientific information already published. It was challenging to include non-science perspectives and to convince technical experts to value local perceptions in the decision-making process. The participants all agreed that the process should not rely on the generation of new scientific information already published. In cases where participants questioned data or their use, the negotiating process was sufficiently flexible to allow for joint fact-finding and the verification on-the-ground effects of different conservations strategies. Further, the system was designed to protect confidential information about bird nesting and lek[2] locations

on private land (Richardson and Peyser, 2005: 22–26).

RECENT DEVELOPMENTS IN GIS AND PGIS

Professional mapping products like ArcGIS and open-source products such as GRASS GIS – used by professional geographers, urban planners, and cartographers – are rapidly being supplemented and even displaced by an explosion of tools made available through the Internet and personal computing devices. Global positioning systems (GPS) are now widely available on personal cell phones, digital cameras, and automobile navigation systems. Individuals who have no interest in mastering the technical features of GIS may simply use an inexpensive digital camera that has GPS built in. Many of the newer 'point and shoot' cameras can provide GPS coordinates and time stamps that simplify the process of geocoding and organizing photographs. Coupled with social networking applications, participants can upload their own photos to a preconfigured website. PGIS researcher Andrew Clark solicited participants for a study involving individuals with disabilities, and the aging. By using geotagged data collected through cell phones, he invited people to submit photographs they had taken. The indexed tags are consistent with broader government data sets in Australia, so Clark and his team could link individual photographic data with 'official' data, where it was mapped and sorted again. 'Essentially,' wrote Clark (2009), 'the site organizes information spatially, thematically, and temporally [sic]'.

New approaches that combine the power of social networking with digital mapping are being explored. The practice of geocoding images (in particular) and uploading them to websites has exploded in the past 2 years. While photo archiving sites such as Flickr, Picasa, and Photobucket are well known, we are seeing increasing numbers of application programming interface (API)-driven[3] sites that enable other features such as image processing, extensive annotation, geocoding, and map-based display. For example, www.Panoramio.com, an image archiving site, has a very clever interface for geolocating images. The company was acquired by Google Inc. in 2007, and the application features a seamless process that takes a user from the uploading of photos, to a tagged photo archive, to their linkage and display on Google Earth (available for download at http://www.google.com/earth). While these applications are not in themselves 'research', they may provide a range of visual data of interest to researchers.

CASE STUDY

My family has lived in the mountains, high mesas, towns, plateaus, and riverbanks of the San Miguel River watershed in Southwestern Colorado for well over a century. The area, to quote local author and eco-educator Pam Zoline, 'has its head in the clouds and its feet in the desert'. In its journey from far above the tree line, the San Miguel River plummets through forests of subalpine fir, blue spruce, and quaking aspen, traverses broad plateaus of pinyon pine and Utah Juniper, and cuts deep canyons into the red rock of the Colorado Plateau.

I used GIS mapping, as a component of visual, place-based research, to capture the personal histories and cultural practices of the current inhabitants of the watershed (Collins, 2009). Utilizing inductive *participatory* methods, my study focused upon the subjective perceptions and qualitative understandings of individuals, and the cultural life of the communities that dot the watershed. The goal of the *Interactive Watershed* project has been to integrate the typical day-to-day planning needs of the region with the desire for a broader conversation about the culture of place. The research methodology employed was a mixed-methods approach following

the specific principles of *participatory action research* (PAR) (Hult and Lennung, 1980; Reason and Bradbury, 2001; Dick, 2002; McNiff, 2002). Their approaches to action research involves systematic cyclical method of planning, taking action, observing, evaluating (including self-evaluation), and critical reflection in a series of generative research cycles (O'Brien, 2001; McNiff, 2002). It is closely related to the notion of formative summative evaluation developed by Michael Scriven (1967).

The study proceeded from the assumption that to understand a given phenomenon I needed to become even more fully embedded in the community – and the natural environment of which it is a part. I was, by definition, a full participant in the process – not a neutral observer. In contrast to more positivist approaches, it was crucial that I maintained flexibility in interacting with (other) participants and remained sensitive to the overarching effects of the environmental and social context.

A test of the PAR methodology is the degree to which there is an improvement of the *performance quality* of the community or an area of concern (Hult and Lennung, 1980; Reason and Bradbury, 2001; Dick, 2002; McNiff, 2002). The PAR approach has a goal of addressing an identified problem in a workplace or community – for example, reducing the illiteracy of students through use of new strategies (Quigley, 2000). In my study I sought to identify and raise awareness of hidden or suppressed aspects of community knowledge about *place*. I used PAR and PGIS as collaborative and complementary methods to demonstrate new ideas and implement action for change involving direct participation in a dynamic research process; at the same time I monitored and evaluated the effects of the investigator's actions with the express aim of improving practice (Hult and Lennung, 1980; Checkland and Holwell, 1998; Dick, 2002). At its core, PAR methods are a way to increase understanding of how change in one's actions or practices can mutually benefit a community of practitioners (Carr and Kremmis 1986; Masters, 1995; Wadsworth, 1998; McNiff, 2002; Reason and Bradbury, 2001).

Participatory research is designed to address specific issues identified by local people, and the results are directly applied to problems at hand. The process is not about a researcher investigating her or his own practices, but is rather a dynamic circle of co-researchers, mostly non-academic, sharing a commitment to social change in a particular situation. The circle is dynamic partly because members of the project choose their own level of involvement. In this sort of *participatory* action research, all participants are considered equal, whether they are formally trained researchers or members of the community (Andrews, 2003). There is a collapse in the usual distinction between *subject* (the researcher and her research) and the *object* (the study participants). The subject/object of the work is generated and guided by the participants using visual, audio, and textual materials produced by and communicated to each other.

Maps for community action

While PAR provided a methodology for community involvement and commitment, PGIS provided the framework for mapping and redistributing the information assembled by the group. While public input is routinely solicited for planning processes in places like the San Miguel River watershed, one problem is the lack of scope of the discussion. Among policymakers and planners, there may be acknowledgement of the *cultural* dimension – i.e. the importance of artifacts, personal expressions, historic and current events – that gives character and meaning to place. But culture is impossible to quantify and difficult to present and thus remains on the periphery, separate, or more or less irrelevant to the conversation that drives typical day-to-day planning – e.g. zoning, infrastructure, environmental impact, and budgetary concerns. From a practical standpoint,

this is completely understandable. But when the fabric of place is defined by subtle cultural practices, approaches are incomplete that do not account for the presence and importance of culture on par with environmental, economic, and social concerns.

Once County Commissioner approvals were secured, I began investigating the online GIS hosted by the San Miguel County Planning Department as a publically accessible portal and objective inventory documenting the culture of the place. I sought to demonstrate that the creative capacity and cultural history of the region could be represented by a new *cultural* layer that exists simultaneously with the more typical layers currently maintained by the GIS office in the County Planning Office: e.g. water quality, grazing units, or zoning. My assumption was that priorities of the planning process were driven largely by the visual representations of the official mapping documents residing in the County Planning Office and in the County Courthouse; changing those views had the potential to change the planning process.

As a 'participant observer,' my roles have included, variously, that of sounding board, collaborator, and technical advisor. It soon became clear that I needed to develop user-friendly protocols to ensure participation and follow-through by the participants. However, early in the project I decided that the protocols of the Internet and standard hypertext markup language would be useful intermediary tools for storing and sharing cultural artifacts and personal projects behind the mapping efforts. But I also determined that this level of technical prowess would make direct individual or community participation essentially impossible. As an alternative I created a 'wiki' or co-authored website. Participants in the Interactive Watershed project had the choice of either uploading their own information to the private wiki, or to simply to send text, images, or other media to me as email attachments. One advantage of the wiki was that all the relevant documents associated with the study were available to participants as they were posted. This obviated the need to send separate attachments for each of the several documents that were required for participation (e.g. cover letter, questionnaire, IRB approvals). All members could upload their own data, add to the discussion, and download documents. If enlisted to help with management of the site, participants could also edit existing content on the wiki. The content of the wiki was, in turn, translated into a working website that reflected the scope of the project as a whole.

While the participants in the current project have not been able to directly input their cultural artifacts and practices into the County's GIS, they have generated meaningful and expressive forms using digital media that I was able to subsequently translate into the necessary protocols for the development of a shared cultural layer on the GIS. In future iterations of the Interactive Watershed, it will be possible for an individual to upload their data automatically with a user-friendly API. This, in turn, would be moderated by a group comprised of the researcher, individual citizens, and representatives of San Miguel County.

In private conversations and public meetings participants were invited to develop original projects that explored creative, expressive, and/or personal perspectives on life in the San Miguel River watershed. There were few rules regarding the structure or media employed for this project; however, projects needed to be able to be represented in some way on the Interactive Watershed website.

The path from initial presentation by the investigator to concrete contribution by participants on the web-based GIS took several steps. Participants were asked to complete a questionnaire regarding their background, comfort with computer-based applications, and views on regional watershed issues and the environment. They also participated in structured face-to-face interviews with me that employed local maps in an image elicitation process. These interviews were

conducted under a variety of circumstances. Whenever possible, they were videotaped; in other cases, an audio recorder was used. In still others, written notes taken during the course of the interview were the only documentation employed.

Participants were asked to focus upon their daily experiences in the watershed and consider a range of possible ways to construct a creative response for the Interactive Watershed project. Through an elucidative process of sharing maps, photographs, and personal experiences, participants began to develop ideas about possible subject matter and creative approaches. This in turn provided the basis for a brainstorming exercise in which different media or topics were discussed.

In many cases, a key task for me was to assist the participant in eliciting *conscious* memories of place. Once a memory or set of associations was made explicit, a variety of self-documentation exercises were employed – such as generating lists of key words or descriptive phrases, creating diaries, making scrapbooks, maps, diagrams, or recordings of personal stories.

One particularly productive elicitation strategy employed various maps of the area; participants were asked to trace with their finger a pathway or place on a regional map that represented a favorite hike or destination. Both physical and online maps were helpful in targeting the site or sites to be used in their projects. For example, a favorite destination or hike could be located on the map. I would then encourage the participant to consider what was special about that place. While not universally applied, some participants found that the creation of collages, bubble diagrams, or 'mental maps' of the processes or features of place were helpful as intermediate steps between conscious identification of place and the development of a specific creative project that reflected that place.

After locating the participant's chosen area within the watershed and providing a few intermediary tools, they began to create solutions that communicated their subjective experience of place. Participants chose multiple and sometimes unexpected pathways. One woman proposed a series of watercolor paintings of various 'put-in-points' along the San Miguel River that reflected her rafting experiences. Pen and ink served another artist for her Tree Portraits – a series of highly representational hand-drawn studies of ancient trees in the watershed (see Figure 25.5). Two participants focused on their ongoing work as poets, but gave special attention to the specifics of place expressed in their work. Still others chose photography to document place. In a number of cases, there was a juxtaposition made between historical and contemporary photos using the kind of 'rephotography' explored by documentary landscape photographers such as Mark Klett (see Chapter 6 in this volume).

As long-term residents of the area, a number of participants had preconceived notions of what they wanted to express. One woman began reflecting on the possibility of visualizing the geomorphology of the region, but then shifted gears and settled upon a topic nearer to her heart – the sacred ground of the Ute Indians that inhabited the Valley Floor just west of Telluride. Another participant, a novelist, had used the Telluride region as the setting for her fictional narratives dealing with relationships and general life experiences. Instead of generating new work, we agreed that her stories already provided a compelling perspective on place.

In addition to their individual projects, participants collaborated on the creation of the Interactive Watershed website itself. I helped develop a web-based method for capturing subjective responses to specific sites in the watershed. For instance, a fifth-grade teacher conducted a summer camp for kids at a site known as the Norwood Bridge on the San Miguel River. She documented children's responses to the river both qualitatively (e.g. drawings, poetry, etc.) and quantitatively (measurements of water velocity, temperature, etc.) using digital

photography and video. I then worked with her in formatting and uploading the documentation of her summer camp experience to her own personal watershed website which was then linked to the Interactive Watershed URL.

One of the serendipitous outcomes was the emergence of common themes among several of the participants' websites. A few examples: the high altitude gardening guide created by a local landscape architect shares a common interest in indigenous flora with the Bridal Veil Falls living classroom; the *venerable* trees documented by the former County assessor resonates nicely with the tree portraits created by the landscape painter; and the downtown history tour of the Town of Telluride finds further detail in the maps and discussion of the early 'Galloping Goose' rail service. These common themes became part of the basis for coding the documents. While these connections were 'discovered' during the actual research process, the resulting data, information, and artifacts were thoroughly and rigorously coded and analyzed to find patterns and themes (Gage and Kalari, 2002).

Different individuals dedicated varying amounts of time on my project: in general, minimum of 12 hours was expected of each participant on project-related activities, although many invested far more time. The number of hours per participant required includes the following:

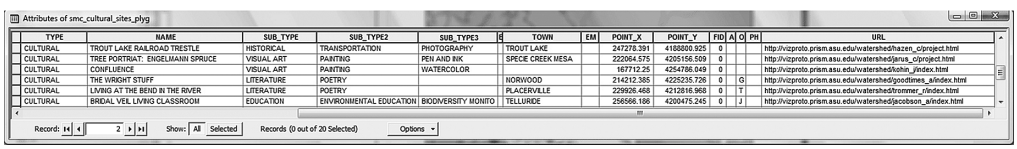
- completion of online survey questionnaire (30 minutes)
- initial face-to-face interview (1–2 hours)
- contribution to wiki and development of Watershed website (6 hours)
- follow-up interview (1–2 hours)
- group meetings involving all participants (pre- and post-; 3–4 hours).

Technical details: Building the GIS

The mapping of participant contributions to geocoordinates within a true GIS requires more than a passing acquaintance with the software. In my case, the authoring environment of choice was the ESRI product, ArcView 9.3.

My first step was to use ArcView to develop a georeferenced database of users' projects. As the database associated with the GIS version of the map evolved, types and sub-types were identified for more targeted searches. I employed the native row-and-column organization of GIS ArtCatalog (dBASE) instead of the branching categories typically found in social science coding processes (e.g. categories, types, classes, etc.). While all project types in the Interactive Watershed GIS are *cultural*, I established a schema in which further detail is captured using the attributes of 'SUB_TYPE,' 'SUB_TYPE2,' etc. – the column headers commonly used in ArcCatalog. For example, a work of fiction is listed first as 'CULTURAL' (TYPE), second as a work of 'LITERATURE' (SUBTYPE), and third as 'FICTION' (SUB_TYPE2). In order to achieve a seamless integration with San Miguel County's GIS, I mimicked the organizational structure of their database (Figure 25.3). I added the additional columns for cultural subtypes and URLs (Internet addresses) associated with each cultural site.

The goal of generating a cultural knowledge base was well-served by this


Attributes of smc_cultural_sites_plyg

TYPE	NAME	SUB_TYPE	SUB_TYPE2	SUB_TYPE3	TOWN	EM	POINT_X	POINT_Y	FID	A	O	PH	URL
CULTURAL	TROUT LAKE RAILROAD TRESTLE	HISTORICAL	TRANSPORTATION	PHOTOGRAPHY	TROUT LAKE		247278.391	4188800.925	0				http://vizproto.prism.asu.edu/watershed/hazen_c/project.html
CULTURAL	TREE PORTRIAT: ENGELMANN SPRUCE	VISUAL ART	PAINTING	PEN AND INK	SPECIE CREEK MESA		222064.575	4205156.509	0				http://vizproto.prism.asu.edu/watershed/jarus_c/project.html
CULTURAL	CONFLUENCE	VISUAL ART	PAINTING	WATERCOLOR			167712.25	4254786.049	0				http://vizproto.prism.asu.edu/watershed/kohn_j/index.html
CULTURAL	THE WRIGHT STUFF	LITERATURE	POETRY		NORWOOD		214212.385	4225235.726	0		G		http://vizproto.prism.asu.edu/watershed/goodtimes_a/index.html
CULTURAL	LIVING AT THE BEND IN THE RIVER	LITERATURE	POETRY		PLACERVILLE		229926.468	4212816.968	0		T		http://vizproto.prism.asu.edu/watershed/trommer_r/index.html
CULTURAL	BRIDAL VEIL LIVING CLASSROOM	EDUCATION	ENVIRONMENTAL EDUCATION	BIODIVERSITY MONITO	TELLURIDE		256566.186	4200475.245	0		J		http://vizproto.prism.asu.edu/watershed/jacobson_a/index.html

Record: 2 Show: All Selected Records (0 out of 20 Selected) Options

Figure 25.3 Detail of GIS database developed by the author for the new cultural layer of the San Miguel County GIS

process. Moving from raw documents to participant-described projects featured on the web (a distillation process of its own), through coded types, and directly into the ArcGIS database was efficient and made sense with respect to the development of the final GIS product.

As indicated earlier, the proposal to include a cultural layer in the extant County GIS was approved by the San Miguel County commissioners. This, in effect, placed cultural practices on par with other regional features deemed worthy of mapping. From the beginning, I envisioned populating the cultural layer with many more entries. Ideally, this process will eventually be automated using API. The goal of allowing users to upload their own data to a true 'participatory GIS' is now feasible technically – but there is a transition cost of between $4000 and $5000. Nevertheless, with the working prototype already embedded in the official GIS, I see raising these funds from the greater Telluride area as achievable.

OUTCOMES

At the conclusion of the project I conducted summative interviews with participants using the website itself and other support materials as image elicitation tools. Participants and other community members were also

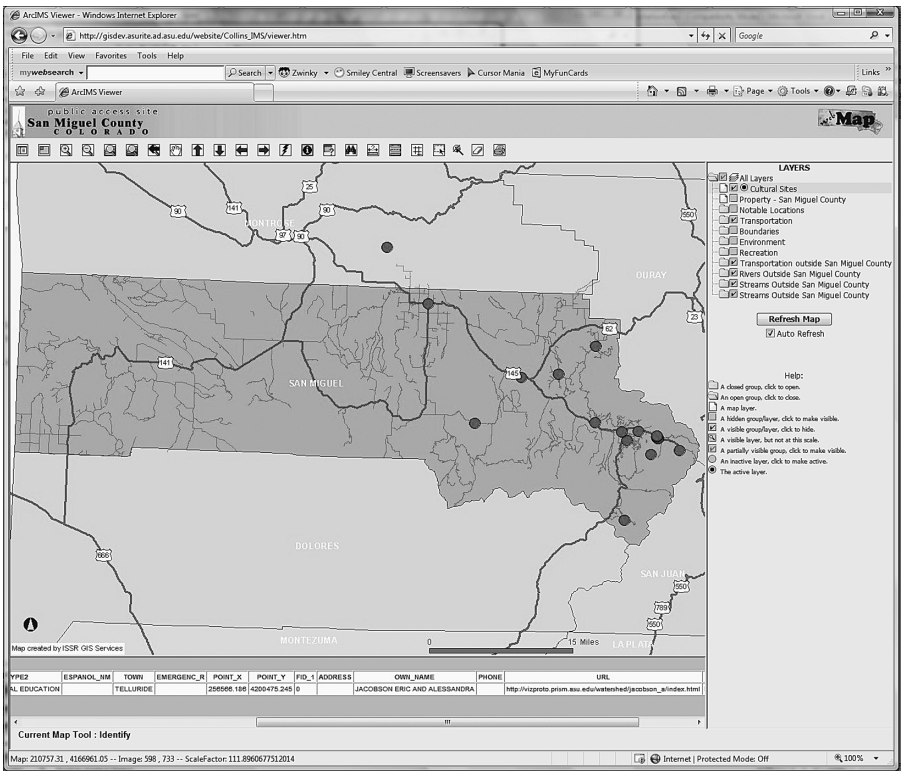


Figure 25.4 Original ArcIMS map by the author detailing the new cultural layer (shown by red dots). This online version of the uses database protocols and map design appropriated from the San Miguel County GIS. An official enhanced version of this map will be published on the San Miguel County GIS in 2011

AU: figures are processed in black and white. so pls update.



Figure 25.5 'Tree Portrait' by Christine Jarus. Watercolor and ink on paper
Source: http://vizproto.prism.asu.edu/watershed/jarus_c/project.html

invited to a community meeting. Using the documentation of the issues and themes gathered during the preliminary phases of the project, a final focus group discussion identified key ideas emerging from the study. Recommendations of the group were video-recorded and included an action list for further work in the area of watershed education and conservation.

While space doesn't permit a full description of the work of all 20 participants, suffice it to say that a wonderful array of artworks and creative projects were produced. The reader can find all of the artworks and related maps linked to the *Interactive Watershed* website.[4] One example, Chris Jarus's *Tree Portraits* (Figure 25.5), speaks to the deep *sense of place* that goes to the heart of the project.

IMPLICATIONS FOR VISUAL RESEARCH AND PLACE-BASED CULTURAL STUDIES

The use of PGIS in decision making or land-use planning could benefit greatly from an infusion of visual techniques and other cultural practices, including photo documentation, site-specific paintings, poems about place, and storytelling and narrative elements that would anchor the map representation within the lived experience of place.

Revealing hidden cultural practices via PGIS and the accompanying dialogue contributes to a close analysis of a region's cultural practices and reveals working intentions, shared experiences, lived realities, and understandings within particular cultural domains. As the recent literature suggests, a

participatory GIS, with its mix of *hard* and *soft* data, provides a richer portrait of place – one that not only provides an accurate description of the physical location and its many features but also offers evidence of lived experience, creative interactions with the land, and public concerns. Rich descriptions of place come as no surprise to environmental writers, poets, visual ethnographers and others who have always understood that it is the people who give form and substance to the contours of a place. Taken collectively, these approaches help to make manifest one's *sense of place* and provide a set of tools for helping to create, describe, and maintain a local culture.

NOTES

1 Personal email correspondence, 5 March 2007.

2 A lek is a gathering of males, of certain animal species, for the purposes of competitive mating display.

3 An application programming interface (API) is an interface that a software program implements in order to allow other software to interact with it, much in the same way that software might implement a user interface in order to allow humans to use it.

4 Available from: http://vizproto.prism.asu.edu/watershed.

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