A User-Centered Model for Community-based Web-GIS

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Abstract: *Like their counterparts in the private and public sectors, community-based organizations are increasingly implementing Web-based geographic information systems (WGIS). Such projects often face a special set of challenges: insufficient financial resources, a set of users with limited technical expertise, and the constant threat of obsolescence. There is a lack of documented research on how grassroots groups and nonexpert users are making use of WGIS. Without more evidence, it is difficult to evaluate whether or not these advances in technology will actually lead to the improvements suggested by their proponents: increased public participation, transparency in government, geographic literacy, and better data-driven decision making by community-based organizations (CBOs). Examining a case study in California, I show that a customized, distributed Web services model is capable of capitalizing on economies of scale and remote technology while maintaining its commitment to serving nonexpert GIS users. Analysis of users from the Neighborhood Knowledge California (NKCA, http://nkca.ucla.edu) system demonstrates that WGIS projects enable anonymous users to upload and integrate local data, facilitate interagency cooperation, and more efficiently utilize publicly available geospatial and demographic data.*

DEMOCRATIZING GIS

The increasing availability of geospatial data on the Internet has led some commentators to declare that "[c]artography has gone from spectator sport to participatory democracy" (Kelly 2005). According to *The New York Times,* the introduction of the open-source application from Google Maps signals the arrival of Internet-based geographic information into the broader public imagination (Darlin 2005) and the advent of "do-it-yourself cartography" (O'Connell 2005). Indeed, this trend is also exemplified by the widespread popularity of Web sites that offer driving directions and quick access to spatial information about local businesses. Both innovative amateur Google Maps developers and the more passive consumers of mapping Web sites find increased opportunity to make use of geospatial data that was previously difficult and expensive to access. But do these trends herald cartographic democracy, or are they better characterized as effects of private market innovation? The implicit message from proponents of "do-it-yourself" cartography is that anyone can use and consume digital geospatial data, and because it is on the Internet, it is accessible to all; in other words, "If you build it, they will come." While this approach may be appropriate for amateur Web developers or corporations with large budgets, community-based GIS projects face a more stringent set of requirements.

The demystification of cartography has accelerated in the past two decades. Since the mid-1990s in particular, GIS has become more accessible to those individuals not trained as GIS professionals. These nonexpert users—by this I mean people with little computer experience, occasional users, GIS novices, and the interested public—are increasingly able to take advantage of mapping software. Friendlier user interfaces, substantial increases in publicly available data, public investment in training and education, and other factors contribute to wider usage of GIS by nonexperts.

Several questions arise on how Web-based technologies can help to meet goals of public participation GIS (PPGIS). Web-based GIS (WGIS) refers to geographic information systems that utilize the Internet to host distributed applications that can be shared and made publicly accessible. Examples of WGIS include mapping applications that aid users in obtaining driving directions as well as property information systems for municipalities. Many of these systems significantly improve the ability of the public to begin using computer mapping. While it has the potential to lead to greater participation (Aitken 2002), WGIS also creates a number of new barriers that are more formidable than they first appear. For example, the range of specialized skills and knowledge required (Traynor and Williams 1997) or the way in which GIS software can be empowering or disempowering (Elwood 2002) may be exacerbated in WGIS. There have been few theoretical treatments of WGIS, and an even smaller number of studies examining how Internet-based GIS can be used as part of PPGIS projects (Kingsley 1999; Wong and Chua 2001, 2004; Casey and Pederson 2002). However, there is a lack of documented research on how grassroots groups and nonexpert users are using WGIS. Lacking empirical evidence, it is difficult to evaluate whether or not these advances in technology will actually lead to the improvements suggested by their proponents: increased public participation, transparency in government, geographic literacy, and better data-driven decision making by community-based organizations (CBOs).

In this paper, I critically examine a case study of community-based WGIS from California, Neighborhood Knowledge California (NKCA, http://nkca.ucla.edu). NKCA and its sister projects at the University of California, Los Angeles (UCLA) have been discussed as grassroots mapping projects that exploit the "utopian potential of GIS" (Warren 2004). Community-based WGIS has the potential to meet the impressive expectations that technological advances enable, but only with careful planning and development, attention to the end-user, and cooperation between agencies and other similar projects. I argue that system architecture, user interfaces, and the development of data partnerships are key components in building sustainable, effective WGIS projects. The case studies demonstrate that a customized, distributed Web services model is capable of capitalizing on economies of scale and remote technology while maintaining its commitment to serving nonexpert GIS users. Analysis of users of the NKCA system illustrates how WGIS projects enable anonymous users to upload and integrate local data, facilitate interagency cooperation, and efficiently utilize the range of publicly available data.

The purpose of this article is to inductively develop lessons from a community-based GIS project in California to ascertain the key mechanisms for realizing the potential of WGIS while addressing its principal challenges. In this case, three of the challenges were: (1) changing software, hardware, and geospatial data, (2) a diverse range of users, and (3) financial sustainability. The challenges were addressed by utilizing a distributed Web services application model, emphasizing the importance of the user interface, and cultivating long-term community partnerships aimed at leveraging limited financial and human resources. In addition, I explore the unintended consequences of the adoption of the WGIS model for community-based GIS. The NKCA project demonstrated that community users discovered novel ways to meet their research needs, often in a manner unanticipated by the developers. Finally, the efficacy of the project was due in part to its insistence on putting people before the technology. This deliberate, sustained approach to community-based WGIS offers more hope for cartographic democracy than does the more recent trends toward open-source geospatial applications of the Google Maps.

THE EMERGENCE OF COMMUNITY-BASED WGIS

In the 1990s, critics painted a fairly ominous picture of GIS based on what they considered to be its inherent limitations, its positivist epistemology, and the need for wholesale critical reconsideration (Lake 1993, Pickles 1995). Following a set of workshops and journal issues dedicated to GIS's underlying epistemological questions, the politics of information, and questions about access and application, a new set of research topics emerged (Obermeyer 1998; Craig, Harris, and Weiner 2002). This group of research has been labeled as "critical" GIS or "GIS and society" debates. Central to these debates are the observations that GIS is not value-neutral, often does not meet the needs of marginalized populations, and has a significant set of limitations. Contrary to the claims of its proponents, it is often unable to model on-the-ground processes. Even when GIS is able to capture local dynamics, the geospatial language that nonexpert mappers employ may not match terminology in the system (Rundstrom 1995, Fonseca and Egenhoffer 1999).

Research focused on participatory GIS builds on previous work in critical GIS in the past decade and most recently on approaches known as public participation GIS or PPGIS, a term derived from the field of urban planning (Obermeyer 1998). Urban planners tout the potential of GIS to aid in equity planning while simultaneously improving transparency in the planning process through bottom-up GIS (Talen 1998, 2000). Warren situates PPGIS projects in the domain of utopian projects where "technology is both the problem and, when inserted into more emancipatory social settings, the potential cure" (2004). In an attempt to move beyond the critical GIS debates of the 1990s, Warren contends that because the limitations of GIS have been exposed and contested, it retains the potential to democratize knowledge and serve as a technique for social activism.

Critiques of GIS have entered a "third wave" that "represents a more nuanced analysis of power" (Schuurman 2000). While the first wave of GIS critiques was often inflammatory and polemical, the second wave was marked by increased cooperation and progress. The third wave signifies the acknowledgment that while the epistemological issues inherent in GIS are no less important, they have been exposed and analyzed. Moreover, the limitations of GIS do not prevent its use for political resistance (Stonich 2002), and in some cases participation in project development can lead to "empowerment" (Parker and Pascual 2002). Despite working on widely varying issues, in different cities, and under substantially different contexts, most groups working on PPGIS projects share similar goals and challenges. Public sector actors often are concerned with transparency in decision making, greater public participation, and efficiency. Influenced by decreased public funding, community service mandates, and service-learning initiatives, university researchers attempt to make their research more accessible and relevant to the community in which they are situated (Esnard, Geleboter, and Morales 2001).

By the late 1990s, many groups active with community-based GIS moved their systems from either desktops or intranets to Web-based applications, leading to an entirely new set of challenges. Because the integrative and communicative features inherent in GIS design lent themselves to Internet technology, the move toward WGIS was probably inevitable and is likely to continue (Goodchild 2000a). Peng and Tsou (2003) contend that Web-based GIS increases the availability of geospatial data, improves dissemination of GIS analysis, and reduces end-user cost through the use of Web clients. Community-based WGIS also offers flexibility for the developers; a Web-based strategy enables customized user experiences and the opportunity to integrate locally produced datasets.

As Wong and Chua assert, however, "Web technology alone is not sufficient to enhance the capability of every community group and resident to use GIS, to change the reality that GIS is a specialized skill, or to significantly level the unequal socio-economic or political relationships that hinder participation in distressed communities" (2001, 2004). To realize the potential benefits, WGIS requires considerable investment and expertise, and its potential has only been realized in a few select cases. Hearkening back to the initial criticisms from human geographers, ineffective or faulty Web-based GIS can actually detract from public participation and community development efforts by discouraging users and heightening the divide between GIS professionals and nonexperts.

WGIS is subject to nearly all the same critiques leveled at GIS in the 1990s (Ramasubramanian 2004). Local production of data remains important (Talen 1998, Aitken 2002, Elwood 2002, Warren 2004), and the success and sustainability of information technology projects often depend on social and institutional factors beyond community control (Elwood and Ghose 2001). For example, data acquisition frequently involves a complicated set of interpersonal contingencies and power relationships rather than clear-cut economic transactions. Community-based GIS is developed with several sets of individuals, including clients (e.g., residents, CBOs, agency staff, politicians, researchers), software developers (e.g., university researchers, agency staff, consultants, etc.), project staff (e.g., community organizers, researchers, GIS experts, computer system administrators), and funders (municipalities, universities, foundations, the federal government). Responsibility for development, maintenance, usage, and financial solvency is dispersed through this network of overlapping actors. WGIS projects add complexity to traditional community-based GIS by increasing development costs, widening the client base, and heightening public visibility. Indeed, many projects have struggled to fulfill their difficult mandates in the face of a dizzying set of institutional relationships. Finally, PPGIS Web sites face competition from other online information resources. Moving the user experience from the desktop to the Web browser instantly creates the enticement of other content on the Internet. The "stickiness"—how long a user will remain on a single Web page—has become increasingly important (Burton and Walther 2001).

Wong and Chua discuss how the Internet offers both opportunities and barriers for PPGIS projects (2001 2004). WGIS offers four types of opportunities: lower cost, data transfer, interactivity, and connectivity. In general, lower costs are derived from increased economies of scale and the ease at which data can be disseminated to those with access to Web browsers. However, WGIS delivers data to anonymous users with a variety of characteristics often considerably more diverse than desktop- or intranet-oriented applications. This creates barriers based on the cost of interactivity, user diversity, copyright costs, and trust and legitimacy (Wong and Chua 2001, 2004). In addition to the increased initial investment in hardware and software development, the cost of interactivity is exacerbated by potential legal liability and decreased control of usage (i.e., copyright issues).

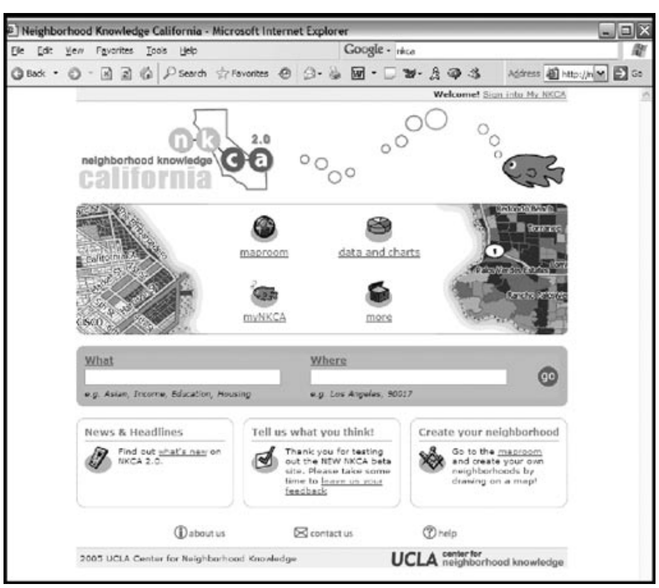

Figure 1. Home page of Neighborhood Knowledge California

The following case study illustrates how these opportunities and barriers have affected a community-based WGIS project in California. By pinpointing the lessons learned in extending PPGIS projects through utilizing Web-based technology, I show that the barriers presented by WGIS can be mitigated by means of developing customized applications that meet the needs of diverse users, conducting extensive and deliberate outreach, and building on existing networks of partners. Moreover, the three key components section that follows highlights the unique structures and institutional practices that emerged from several years of software development, outreach, and applied research.

Methodology

The argument presented in this paper represents an inductive analysis of three types of data based on my employment at the UCLA Advanced Policy Institute (API) from 2000 to 2003.[1] First, quantitative and qualitative data from user surveys provided information on the usage and demographics of project participants. In addition, I was a participant-observer; my experience as a GIS Web developer and technical assistance provider offered firsthand understanding of the day-to-day activities of both users and staff. Finally, published evaluation reports and articles of the API projects provided a historical context (Krouk, Pitkin, and Richman 2000; NKLA 2000; Richman and Kawano 2000; Modarres 2001; Pitkin and Rattray 2002; Steins 2003).

Background

Neighborhood Knowledge California represents one stage in the evolution of several related projects. The Center for Neighborhood Knowledge (CNK, formerly known as the Advanced Policy Institute) has been working on similar community-based WGIS projects since 1996. CNK is an applied research institute affiliated with the School of Public Affairs at the University of California, Los Angeles. Similar to research institutes at other large urban universities, CNK operates in several interrelated university-community partnerships, arrangements that are often fertile ground for successful community mapping projects (Esnard, Geleboter, and Morales 2001).

The first major project completed by the institute was Neighborhood Knowledge Los Angeles (NKLA, http://nkla.ucla.edu). NKLA presents housing and property data in a bilingual (English-Spanish), user-friendly format delivered through online maps and tables (Figure 1). Aimed at improving housing conditions for the city of Los Angeles, it is notable for the way it incorporated Web-based GIS analysis with a wide range of publicly accessible information. The longer-term goal of NKLA was to assist in monitoring residential housing conditions by providing an "early warning system" of housing disinvestment (Krouk, Pitkin, and Richman 2000; Richman and Kawano 2000). The project also deliberately promoted the democratization of public information, signified by its motto: "Neighborhood Knowledge is not just for the experts." Indeed, according to survey data of registered users shown, it was used in almost equal proportions by city staff, residents, community organizers, CBOs, and researchers. Nearly half of the users identify themselves as nonprofit employees, tenants, or community residents (i.e., nonexpert users). An independent evaluation of the project indicates that of the 5,200 registered users, 10 percent visited more than five times (Modarres 2001).

Despite the project's initial success, both project staff and Web site users identified areas that could be improved. Staff realized that NKLA´s maps of housing disinvestment tended to reinforce negative assumptions about housing conditions in Los Angeles neighborhoods. At the same time, several community groups began to seek alternative methods for utilizing NKLA´s geographic information and suggested customized tools tailored to their organizational objectives. Building on the "asset mapping" model popularizing by Kretzmann and McKnight (1993), NKLA staff produced a new spin-off program called "Interactive Mapping in Los Angeles" or "IAMLA," aimed at highlighting the wealth of social and cultural assets in several neighborhoods. The project resulted in Web-based maps of three low-income neighborhoods in Los Angeles with digital photos and bilingual descriptions created and uploaded by the high school students (Pitkin and Rattray 2002). Although these local projects were individually successful, they required additional funding and a significant investment in conceptual training and Web site development.

From 2000 to 2003, several related projects spun off from NKLA. Although each used the same basic technical platform, focused on addressing issues related to the digital divide (NTIA 1999), and offered user-friendly mapping tools for community research, they each had different funding strategies, clientele, user interfaces, and programmatic staff.[2] The Living Independently in Los Angeles (LILA) project launched in 2000 as "a consumer-directed and regionally focused online project to benefit people with disabilities living in Los Angeles County." Mirroring the model established by IAMLA, it utilized the labor of community researchers (most of whom were people with disabilities) to collect information. The technical and sociopolitical lessons of the collective experiences set the stage for NKCA (NKLA 2000).

While LILA and IAMLA demonstrated that uploading user "assets" enhances the "PP" in GIS projects, NKLA's integration of relevant administrative datasets, accessible maps, and bilingual interface exhibited the utility of WGIS. However, each of these projects targeted specific user groups, faced technological challenges, and in some respects lacked scalability. NKCA was developed as a new platform that incorporated the features of the prior projects, added new datasets, two novel applications, and extended the coverage of the maps to the state of California. NKCA also took advantage of an established set of community partnerships, a highly trained staff, and a loyal base of Web site users. At present, NKCA focuses on assisting community groups working in the area of affordable housing and community reinvestment. In addition to general demographic and economic information, NKCA features data relevant to researchers working on fair-lending and fair-housing issues.

For comparative purposes, we can look at statistics from the three-month period, May to July 2005.[3] NKCA received just over 4,000 visitors over this period at an average of 131 per day. Thirty-two percent of these users were "repeat visitors," a figure valued by the staff. The site generated an average of 16,241 hits per day (although this can be a misleading statistic), a measure that has shown a steady but gradual increase over the past four years.

Key Components in Community-Based WGIS

Three aspects of community-based WGIS projects are vital to their eventual success: building effective partnerships, emphasizing accessibility in the user interface, and developing flexible system architecture. While these aspects were important in community-based GIS prior to the move toward the Web-based strategies, they now have increased significance.

The common denominator in the CNK projects is the emphasis on the user. Although many WGIS projects prioritize technology and often lose sight of the human user, CNK maintained the mantra of placing people first. As shown in the following section, this philosophy pervaded each aspect of the project.

Durable Community Partnerships

The most important factor in these projects is the development of community partnerships. Various types of partnerships aim at achieving different goals, each playing a key role in "data intermediation" (Wong and Chua 2001, 2004). Funding partnerships ensure the financial solvency of the project. Partnerships with local governments encourage the use of Web-based software in the delivery of public services (e.g., NKLA). Publicly accessible data assists municipal staff by both helping them with their own tasks and helping them meet their obligations to disseminate information to city residents. Making data accessible differs from mere availability because the public can actually acquire and use it. Personal relationships, carefully nurtured over time, can be important factors in the success of maintaining such partnerships. Each of these partnerships provides clientele and reciprocal benefits, leading to increased stability.

One distinctive feature of the CNK model was the makeup of the staff. Most of the staff had experience in the discipline of urban planning, and more than 90 percent of the permanent staff members (as opposed to the students or the part-time staff) also had experience and interest in the subfield of community development. The staff was highly involved in strategic planning and organizational development and had worked in community organizing in some capacity. Thus, the cultural divide (Haklay and Tobón 2003, Urban-Institute 2005) that often exists between

GIS experts and community-oriented staff was absent.

Moreover, most of the staff had achieved competency in four key areas, and in a fairly consistent sequence. They were first involved in community development, followed by training as urban planning academics. Next, they become proficient in GIS, and finally achieved some level of competence with dynamic software programming and database manipulation. A few of the staff members lacked experience or proficiencies in some of these areas, but for the most part it was a staff with high technical competence in Web development and GIS, significant community experience, and solid academic credentials. Most important, they were urban planners first and computer scientists second. Like early pioneers of GIS (McHaffie 2000), they were unsatisfied with the existing technology and were ideologically committed to its modification, eventually developing a community-based WGIS.

One of the most exciting and unpredictable results of the NKCA project has been the range of applications it has been used for. Because it offered no-cost tools on the Web, it was impossible to predict how actual usage would occur. Three types of cases show how it has been used: a legal services organization from the San Francisco Bay Area, a coalition of CBOs in San Diego, and a local city planner from San Luis Obispo.

1. The multiplier affect: The NKCA staff certainly could not have predicted that another nonprofit support organization would create their own tutorials specifically aimed at their clients in need of demographic information. Legal Services of Northern California attended one of the NKCA training sessions and subsequently created in-depth guides for two sections of the Web site: the data uploader and the neighborhood creator. This demonstrates that by sharing research tools on the Internet, nonprofit organizations are better able to pool their resources. Rather than trying to offer GIS services on their own, Legal Services simply adapted the NKCA project for their own clients. The ease with which they adapted it to their own needs stems from the accessibility of the NKCA user interface. In other words, projects that can address the needs of several organizations (i.e., easy-to-use demographic data and maps at the local level) help strengthen the nonprofit sector as a whole.
2. Leveraged resources: The California Coalition for Rural Housing (CCRH) fits into a slightly different model. A statewide low-income housing coalition, CCRH provides technical assistance and research for its member organizations (mostly community development corporations). The NKCA staff worked with the CCRH staff to offer customized training periodically in Sacramento, California, and the surrounding region.[4] At the request of the CCRH staff, NKCA was adapted to better address GIS analysis in rural areas, where the size of census units and street addressing creates a special set of challenges (Goodchild 2000b).
3. User-friendliness: Municipal employees also exploit NKCA's free tools. As we learned with NKLA, agencies such as the Housing Department of the city of Los Angeles often have difficulty obtaining current, easy-to-use demographic and housing information. Much of this difficulty comes from within the city: they often face significant challenges securing data from coworkers and even steeper barriers from other city agencies. In the NKCA case, the location of data at UCLA helps increase legitimacy and circumvent the reluctance to share.

This housing and demographic information is vital to the needs of city staff, as is shown by the feedback received from a planner in central California who works on housing and economic development issues:

> I help to administer federal funds allocated to the County from the U.S. Department of Housing and Urban Development (HUD). The HUD regulations require grant recipients to prepare and adopt a five year Consolidated Plan and a fair housing plan (the Analysis of Impediments to Fair Housing). These documents are the "road maps" that show HUD how the jurisdiction will prioritize its efforts with regards to distributing the federal funds and removing impediments to fair housing.
>
> A key component of both documents is the Demographics section, which describes the characteristics of the local population base, income levels and housing market. Thanks to the UCLA Neighborhood Knowledge program, I was able to create valuable maps that showed information such as concentrations of various ethnic groups, areas of high and low household incomes, areas with high poverty levels, and areas of high rental and ownership housing. I created customized maps showing large portions of the county and also specific communities of interest. I created approximately 36 maps, and have used 8 of them in the fair housing plan. We will be using some of the maps in the Consolidated Plan as well.[5]

This example is particularly interesting because it demonstrates precisely how maps are used in active urban-planning processes. It also illustrates the anonymous nature of WGIS: in this case, the NKCA staff had no direct contact with this individual. The staff did not conduct outreach in San Luis Obispo County and simply received the feedback through the Web site. There are similar case examples from other areas of California, especially the small northern cities. While many users require customized browsing experiences, some individuals can create extract data with little or no assistance.

Other cases of collaboration involve partnerships with statewide or national organizations. NKCA has had formal relationships with CCRH (affordable housing), the California Reinvestment Committee (fair lending), and InfoOakland (regional data intermediary and project of Urban Strategies Council). These partners offer feedback to the NKCA staff, interface directly with local users, and develop joint funding opportunities. In addition, the staff partnered with data intermediaries in San Francisco and New Orleans with the idea that Web site content could be shared among similar organizations. For example, the NKCA staff worked with the Greater New Orleans Community Data Center to create short educational tutorials aimed at "nonexpert" mappers. The NKLA, GNOCDC, and Urban Strategies Council are all part of a network of projects organized by the National Neighborhood Indicators Partnership (NNIP).[6]

I have already argued that partnerships play a critical role in project sustainability, but the NKCA case also illustrates a more subtle point. Particular relationships between individuals are the building blocks of these partnerships, and they are built in unpredictable ways. The virtual nature of WGIS accentuates these effects because of the emphasis on sharing of data and the ease of passing computer codes. In many cases, collaborative work occurs even without in-person meetings. For many who consider themselves "techies," this may be the preferred mode of collaboration. In addition, dichotomies of self-identity arise between those who consider themselves "geeks/coders/ techies" and "technophobes/nontechnical people." While these might be false and permeable distinctions, they often function as bonding mechanisms. The "geeks" from two different partner organizations forge bonds that enable them, when necessary, to transcend organizational boundaries.

Beyond the formal relationship that exists between, for example, a research institute and a city agency, other types of individual relationships complicate the situation. Individual staff members from each organization confront a bewildering set of pressures that may include the organizational mandate, manager-employee dynamics, institutional constraints, and simple interpersonal rapport. In some cases, especially when project success or failure can hinge on the acquisition of a single set of data, these unaccounted interpersonal factors become paramount. These processes can work to advance or inhibit project objectives. For example, a harmonious interpersonal relationship between software developers can lead to the sharing of data against the (formally or informally stated) wishes of their supervisors. Such sharing takes the form of partial datasets that can then be covertly used to further develop applications in ways that subsequently become appealing to both sides of the partnerships. In other cases, relatively simple data-sharing tasks are blocked for reasons that have nothing to do with technology but rather stem from interpersonal conflict or political maneuvering. Critical to these partnerships are "advocates" or individuals who will champion their partner organization to help sustain the collaboration.

The Centrality of the User Interface

In contrast to the ease with which people can now use mapping Web sites such as MapQuest or Google Maps, users and developers of community-based mapping systems face an array of challenges. Building on the critiques from the PPGIS literature, we know that nonexpert GIS users must have easy-to-use, intuitive interfaces that do not require excessive training or copious time to understand (Haklay and Tobón 2003). They also often require localized data, or at least the ability to easily combine their own data with system-wide base data. In addition, a digital divide (though perhaps diminished) still exists for many nonprofit organizations and low-income users. For those with limited access to broadband connectivity, software applications must have lightweight clients.

The Web interface is extremely important to end-users of community-based WGIS (Haklay and Tobón 2003). While nonexperts require simplified interfaces that remove unnecessary tools and functions, other users can benefit from uncluttered applications. Indeed, GIS professionals also face limited amounts of time to complete tasks. For all users, interfaces that generate efficient task completion reduce frustration and improve output. When community-based projects have "empowerment" as part of their mission, they endeavor not only to help people accomplish existing tasks but also build capacity. Capacity building leads to the acquisition of new knowledge or skills that can be transferred to other objectives. For example, the NKCA aims at educating people about the topics of affordable housing and fair lending while improving their geographic literacy.

Along with the need for proper terminology, there is a persistent need for ways to easily incorporate localized data in community-based GIS. Data quality is the crucial foundation in geospatial analysis (Aronoff 1989, Schuurman 2004), but collecting accurate reliable data can be a challenge in the CBO context. CBOs often rely on community service from students or people untrained in data collection, and often have limited budgets and time frames. There is, for example, a great need for cost-effective methods to integrate tabular, address-based survey information in GIS.

The NKCA features two unique applications that illustrate how cutting-edge technology particularly benefits users with limited technical capacity in novel ways (Steins 2003). The first is the "Data Uploader," a tool that provides a method for anonymous users to incorporate their own tabular data (e.g., a list of addresses in a spreadsheet) to create their own map layers. Uploading addresses is an important and routine procedure in desktop GIS, but there are two difficulties for the mapping novice. For one, it normally requires licensed GIS software. Secondly, using desktop software often generates considerable confusion and a significant failure rate.

To mitigate these challenges, the NKCA provides a four-step process that is comparable to uploading photos to send via e-mail. After uploading and naming their tabular data, users can then view their list of addresses as a point-based map. Moreover, they can compare their data to information included in the NKCA data library. For example, a community organizer from the San Francisco Bay Area wanted to know if his coalition of churches was in the same sections of the city that had large concentrations of African-Americans. Using his directory of churches, he uploaded the addresses into the NKCA, and then viewed those data points against a thematic map of ethnicity by census tracts. He found that several churches were clustered in sections of the city while others parts were relatively underserved. While this procedure certainly has methodological limitations, for his purposes, it was sufficient and, in fact, quite illuminating.

The second application—referred to as "Create your own neighborhood"—helps users define research areas and then quickly obtain summary statistics for a particular census tract or

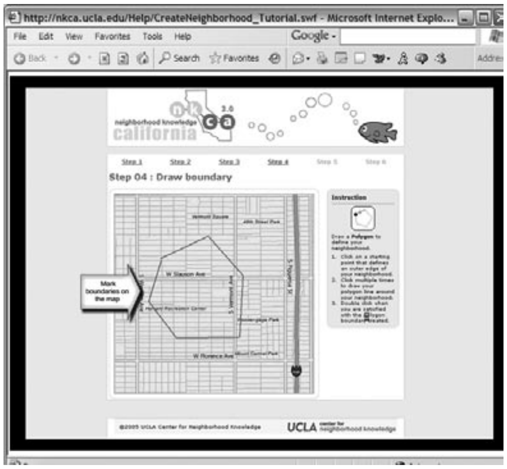

Figure 2. "Create Your Own Neighborhood" tool

group of census tracts. While an analogous query could be done using the American Factfinder from the U.S. Census, this tool has several advantages. First, while the Factfinder Web site only allows neighborhood selections based on menu-driven forms, the NKCA uses an interactive point-and-click method by which users see the census tracts or block groups they are interested in studying (Figure 2). Needless to say, very few people—professional or otherwise—are aware of the number of their census tract. Taking advantage of contextual cartographic clues such as main streets and physical landmarks helps users pinpoint their target areas. The second advantage of the NKCA application is that you can save your "neighborhood" in a profile and thus make it available for later queries or for use with the Data Uploader tool. Finally, the ability to share these neighborhood areas means that different users can distribute their results and use the tool as a collaborative, interactive way to define geographic boundaries. In training workshops, the NKCA staff has used this tool to help the CBO staff define the boundaries of their intended target area.

These two applications exemplify how WGIS technology can be adapted to perform functions previously unavailable to CBOs. Through the Data Uploader and "Create your own neighborhood" tools, we see how GIS technology can be effectively modified to benefit end-users. Geographers have made the case that GIS is not inherently rigid, but through rewiring can be adapted to meet unforeseen user requirements (Kwan 2002). "Writing the cyborg" entails dealing with the underlying technology directly; use of engaged, feminist approaches can make "GIS and geography a more equitable place not only for women but for many underrepresented and less powerful groups" (Schuurman 2002). Although the NKCA's data uploader tool does not address epistemological critiques, it does serve as an example of applied research that altered GIS technology. By opening a piece of the "black box" of ArcIMS and rewriting the code to make the uploading feature free to nonprofit users, the NKCA democratizes the ability to create point-based maps. This also illustrates the general point made by Craig (2005): that individuals (e.g., software developers) can make a lasting impact.

Finally, the NKCA emphasizes education. The driving philosophy behind the user interface is to teach users about spatial analysis as opposed to simply offering maps over the Internet. Throughout the Web site, context-sensitive help located in orange boxes gives definitions for geographic terms, offers examples of how maps might be used, and points to online tutorials and Flash-based GIS instructional materials. The project focuses on how spatially based social science research can be used for community action.

System Architecture and Flexible Development

The technical strategy in Web site development should correspond to the larger project objectives. In the NKCA case, a flexible technological back end enabled the creation of effective community partnerships and a dynamic user interface. By tinkering with the basic templates and architecture offered by commercial GIS products, a customized software and hardware platform opens the door for Web sites that better meet the needs of community-based GIS projects.

With the dual pressure of underfunding and onerous user requirements, it is vital that the development strategy makes the best use of limited resources. The Internet opens up the possibility of delivering community-based GIS services in a manner that can be highly cost-effective. By building database-driven Web applications with a modular programming approach, system developers can take advantage of reusable application components and create more extensible applications. Developing Web services also enables remote administration and, more important, the ability for system users to customize maps, upload data, and share files—in short, to access free mapping and analysis tools with a Web browser and an Internet connection. Although this type of development approach required skilled programmers, planning, and an initial investment, in the long run it may prove more sustainable for promoters of community-based GIS.

WGIS offers a new set of possibilities for system designers. Database-driven, scripted Web applications enable end-users to store, manipulate, and export spatial and personal information in ways that were previously prohibited by cost or hardware requirements. Likewise, the sheer amount of client (automated and solicited) feedback generated a large knowledge base of information.

Building on nearly a decade of user experiences from the preceding neighborhood-based GIS projects, the NKCA developers diligently compiled and incorporated feedback from a wide variety of people during regularly scheduled workshops, university and high school class sessions, meetings, academic conferences, and public demonstrations. Prioritizing the user also informed the design philosophy. Computer code was intended to operate in modules that could be extended in the future as needed to respond to changing technologies or users' needs. Online feedback mechanisms, quarterly community workshops, and ongoing evaluation tools helped provide fresh data to guide redevelopment. When the NKCA was first launched, there was little published or experiential knowledge about how nonexperts might use WGIS in their work. Many of the applications were experiments, and so it was important that they were built in a manner that was easy to redevelop and change as necessary. In fact, in 2005, version 2.0 of the NKCA launched and incorporated the large of amount of user feedback that the staff received in the NKCA 1.0 period (December 2002 to February 2005).

Unleashing the Potential of Community-Based WGIS

The NKCA case, along with other projects developed by the API/CNK, demonstrates the importance of user interface, application architecture, and partnerships in developing sustainable community-based WGIS projects. Moreover, these projects reveal the critical importance of attempts to alter existing technological products, the salience of the personal relationship behind partnerships, and the role of key individuals in PPGIS projects.

While the claim that "[c]artography has gone from spectator sport to participatory democracy" (Kelly 2005) might be slightly premature, WGIS does have the potential to alter the way that the general public uses geospatial data. At its best it can serve as a method for reducing the content aspect of the digital divide. As the following user indicates, it is especially effective when it transmits information in such a way that preserves complexity but keeps things simple:

> Thank you SO much for the presentation. I cannot tell you how great it was for me to see such a well-designed site. You-all have taken very complex information and made it accessible. Hey, are you closet librarians, or what? I see a lot of websites, and yours is absolutely, truly one of the best. It is a true service, and really is what bridging the digital divide is all about.[5]

If the NKCA and other WGIS projects can continue to meet the growing demand for easy-to-use maps and data, they will provide the type of contribution envisioned by optimistic proponents of PPGIS. They can also level the playing field between technocrats or professionals and community activists who lack either the time or expertise in data collection and analysis.

The NKCA project demonstrates that WGIS can deliver functionality that is "as easy to use as ordering a book or sending an e-mail" (Haklay and Tobón 2003). While many projects utilizing off-the-shelf WGIS contain overly complicated interfaces and nonintuitive iconography, this is not an inherent limitation. Rather, the ability to first dissect and then rebuild the system actually facilitates user-centered design and helps solve the problem of the increasing black-box nature of commercial GIS products. This strategy subverts the "trickster nature" of commercial GIS products, such as the geocoding process (Warren 2004). Although it seems counterintuitive for PPGIS projects (that often subsist on severely limited budgets), such Web-based projects must invest substantially in infrastructure development, user support, and interface design while simultaneously sustaining themselves financially and responding to the needs of their predominantly nonexpert users, who are often the individuals best positioned to contribute to community development projects.

Endnotes

1 As part of the development and outreach team, I participated in the coproduction of the various API projects. I personally served first as a junior team member on the NKLA project and then as the project manager for the NKCA project. In this capacity, the argument presented in this paper is undoubtedly rooted in the joint experiences of those involved in the creation and use of the various projects. Quotations, figures, and statistics have been used with the permission of the UCLA Center for Neighborhood Knowledge.

2 Neighborhood Knowledge California: http://nkca.ucla.edu; Neighborhood Knowledge Los Angeles: http://nkla.ucla.edu; Living Independently in Los Angeles (LILA): http://lila.ucla.edu; Healthy City: http://www.healthycity.org; UCLA in LA: http://la.ucla.edu.

3 Special thanks to Charanjeet Singh for providing Web-usage statistics.

4 The training information page for CCRH is located at http://www.calcruralhousing.org/ Home_NKCA.htm.

5 Quotations were provided anonymously to the NKCA through a Web-based feedback form.

6 Building on the social indicators movement in the 1970s (Kingsley 1999), NNIP is "a collaborative effort by the Urban Institute and local partners to further the development and use of neighborhood-level information systems in local policymaking and community building" (Urban-Institute 2005). The CNK staff profited from collaboration with these nationwide partners.

Acknowledgments

I would like to extend my appreciation to my former colleagues at UCLA, our community partners, and the users of the NKCA and NKLA Web sites. I would especially like to thank Sarah Elwood for her guidance, and Wendy Vogt and Brian Burke for their insightful comments.

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References

Aitken, S. C. 2002. Public participation, technological discourse and the scale of GIS. London: Taylor and Francis.

Aronoff, S. 1989. GIS: A management perspective. Ottawa: WDL Publications.

Burton, M. C., and J. B. Walther. 2001. The value of Web log data in use-based design and testing. Journal of Computer-Mediated Communication 6(3). Available at http://jcmc.indiana.edu/vol6/issue3/burton.html.

Casey, L., and T. Pederson. 2002. Mapping Philadelphia's neighborhoods. In Craig, W. J., T. M. Harris, and D. Weiner, eds., Community participation and geographic information systems. New York: Taylor and Francis, 65-76.

Craig, W. J. 2005. White knights of spatial data infrastructure. Urban and Regional Information Systems Association 16 (2): 5-13.

Craig, W. J., T. M. Harris, and D. Weiner. 2002. Introduction. In Craig, W. J., T. M. Harris, and D. Weiner, eds., Community participation and geographic information systems. London: Taylor and Francis, 1-16.

Darlin, D. 2005. A journey to a thousand maps begins with an open code. The New York Times, October 20.

Elwood, S. 2002. GIS and collaborative governance: understanding their implications for community action and power. Urban Geography 22 (8): 737-59.

Elwood, S., and R. Ghose. 2001. PPGIS in community development planning: framing the organizational context. Cartographica 38 (3/4): 19-33.

Esnard, A.-M., M. Geleboter, and X. Morales. 2001. Environmental justice, GIS, and pedagogy. Cartographica 38 (3/4):53-61.

Fonseca, F., and M. Egenhoffer. 1999. Knowledge sharing in geographic information systems. In Scheuermann, P., ed., The Third IEEE International and Data Engineering Exchange Workshop, Chicago, 85-90.

Goodchild, M. F. 2000a. Communication geographic information in a digital age. Annals of the Association of American Geographers 90(1): 344-55.

———. 2000b. GIS and transportation: status and challenges. GeoInformatica 4 (2): 127-40.

Haklay, M., and C. Tobón. 2003. Usability evaluation and PPGIS: towards a user-centred design approach. International Journal of Geographical Information Science 17 (6): 577-92.

Kelly, K. 2005. We are the Web. Wired, August 2005.

Kingsley, T. 1999. Neighborhood indicators: Taking advantage of the new potential. In American Planning Association Conference. 1999. Seattle, Washington.

Kretzmann, J. P., and J. L. McKnight. 1993. Building communities from the inside out. Evanston, IL: Asset-Based Community Development Institute, Northwestern University.

Krouk, D., B. Pitkin, and N. Richman. 2000. Internet-based neighborhood information systems: a comparative analysis. In Michael, G., ed., Community informatics: enabling community uses of information technology. Hershey, PA: Idea Group Publishing, 275-97.

Kwan, M.-P. 2002. Feminist visualization: re-envisioning GIS as a method in feminist geographic research. Annals of the Association of American Geographers 92(4): 645-61.

Lake, R. W. 1993. Planning and applied geography: Positivism, ethics, and geographic information systems. Progress in Human Geography 17: 404-13.

McHaffie, P. 2000. Surfaces: tacit knowledge, formal language, and metaphor at the Harvard Lab for Computer Graphics and Spatial Analysis. International Journal of Geographical Information Science, 755-73.

Modarres, A. 2001. Evaluation report of Neighborhood Knowledge Los Angeles (NKLA). Los Angeles: California State University, Los Angeles, 1-38.

NKLA.2005. NKLA How-to Kit 2000, September 12. Available at http://nkla.sppsr.ucla.edu /Master.cfm?Page=HowToKit/main.cfm.

NTIA 2005. Falling through the Net: Defining the digital divide 1999, November 12. Available at http://www.ntia.doc.gov/ntiahome/fttn99/FTTN.pdf.

O'Connell, P. L. 2005. Do-it-yourself cartography. New York Times Magazine, December 11, 2005, 66-67.

Obermeyer, N. J. 1998 The evolution of public participation GIS. Cartography and Geographic Information Systems 25 (2): 65-67.

Parker, C., and A. Pascual. 2002. A voice that could not be ignored: community GIS and gentrification battles in San Francisco. In Craig, W. J., T. M. Harris, and D. Weiner, eds., Community participation and geographic information systems, eds. London: Taylor and Francis, 55-64.

Peng, Z.-R., and M.-H. Tsou, 2003, Internet GIS: distributed geographic information services for the Internet and wireless networks. Hoboken, NJ: Wiley.

Pickles, J. 1995. Ground truth: the social implications of geographic information systems. New York: Guilford.

Pitkin, B., and N. Rattray. 2002. Community mapping for Neighborhood Knowledge in Los Angeles. Community Technology Review Winter-Spring: 15-17.

Ramasubramanian, L. 2004. Knowledge production and use in community-based organizations: examining the use of information technologies. Cityscape 7(1): 165-91.

Richman, N., and Y. Kawano. 2000. Neighborhood information is NOT just for the experts. Shelterforce September/October 2000.

Rundstrom, R. A. 1995. GIS, indigenous people, and epistemological diversity. Cartography and Geographic Information Systems 22 (1): 45-57.

Schuurman, N. 2000. Trouble in the heartland: GIS and its critics in the 1990s. Progress in Human Geography 24 (4): 569-90.

———. 2002. Women and technology in geography: a cyborg manifesto for GIS. The Canadian Geographer 46 (3): 258-65.

———. 2004. GIS: a short introduction. Oxford: Blackwell.

Steins, C. 2003. E-government and planning profiles: Neighborhood Knowledge California, a review of Neighborhood Knowledge California. American Planning Association.

Stonich, S. 2002. Information technologies, PPGIS, and advocacy: globalization of resistance to industrial shrimp farming. In Craig, W. J., T. M. Harris, and D. Weiner, eds., Community participation and geographic information systems, eds. London: Taylor and Francis.

Talen, E. 1998. Visualizing fairness. Equity Maps for Planners 64 (1): 22-38.

———. 2000, Bottom-up GIS: a new tool for individual and group expression in participatory planning. Journal of the American Planning Association 66 (3): 279-94.

Traynor, C., and M. G. Williams. 1997. A study of end-user programming for geographic information systems. In Empirical studies of programmers: seventh workshop. Alexandria, VA: ACM Press, 140-56.

Urban Institute. 2005. National Neighborhood Indicators Partnership home page 2005, November 11. Available at http://www.urban.org/nnip/.

Warren, S. 2004. The Utopian Potential of GIS. Cartographica 39 (1): 5-16.

Wong, S., and Y. L. Chua. 2001/2004. Data intermediation and beyond: issues for Web-based PPGIS. Cartographica 38 (3 and 4): 63-80.