Chapter 2
The Digital Revolution

2.1 Introduction

In the last chapter, I described a 1995 settlement negotiated between a powerful corporation (an insurance company) and relatively powerless homeowners. In this classic David vs. Goliath scenario, against all odds, the homeowners emerged victorious. Digital technologies, data, and information, anchored by sustained community activism influenced settlement negotiations. In this chapter, I propose that the roots of this particular type of digitally mediated community advocacy were established a long time ago – in the late 1960s in fact. In this chapter, I trace the history of the digital revolution that occurred in parallel with the more prominent civil rights revolution in the United States.

I propose that the unique circumstances that have shaped digitally mediated community advocacy in the United States must be understood in order to better understand its multiple dimensionalities. But before we get to that, I want to remind you about few basic assumptions that I've made already. These assumptions may be pretty obvious; nevertheless it is good scientific practice to make one's own assumptions and beliefs as explicit as possible.

The entire discussion in Chap. 1 is centered around three inter-twined themes, planning, participation, and digital technologies. This leads us to our first assumption – that there is something valuable to be learned in investigating the nature of public participation and the role that geo-spatial technologies can play in facilitating or hindering such participatory activities. Implicit in this discussion is the notion that the use of digital technologies are "socially constructed". This means that all technologies, in our case, information and communication technologies are not imbued with inherent power. Rather, the manner in which the technologies are designed, deployed, and disseminated has significant social, cultural, and political consequences that can be positive or negative. For instance, a cell phone can be used as an instrument for simple communication, for surveillance (when you enable the phone's GPS capability to track down the location of your child), or as a reward (when a school allows its high achievers students to use their cell phones while in school). As the I-Phone ads promise, "there's an app for just about anything"! The ad draws our attention to the different ways in which software developers and

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users have created and adapted a basic communications device to accommodate both practical and emotional needs.

Another assumption is that digital technologies are transforming the nature of contemporary planning practice, and these transformations can be understood only in observing planning where and when it happens. Planning practice is governed by national, regional, and local cultural and political contexts of decision making. These contexts shape how technologies are deployed in the service of fostering public participation. A corollary to this observation is that the adoption and use of technologies is a dynamic process – i.e., planning practice is affects the design and development of tools and new tools help re-energize planning practice. For instance, GIS has now become part of the strategic planning playbook of many community organizations (CBOs) partly as a reaction and adaptation to the use of GIS by planning agencies. At the same time, CBOs have also adopted GIS because it provides an edge (or is perceived as providing an edge) while negotiating with more powerful entities.

Finally, for the purposes of this book, I am proposing that geo-spatial technologies are a subset of a larger set of digital tools and dependent on a global data infrastructure. The development of GIS tools and processes cannot be understood without understanding the digital revolution. Keep these assumptions in mind; we'll return to them later, as we attempt to draw some general conclusions about the three core topics that will focus our discussion – technologies themselves, public participation, and the day-to-day practice of planning.

2.2 The Digital Revolution

There are countless narratives about information and communication technologies, and each narrative has its own starting point. For example, one could begin by focusing on the Pony Express, a cutting edge form of information and communications technology in its day. Suffice it to say that technological innovations often occur in relatively short spurts of intense development, and one innovation often triggers another. For instance, in an earlier era, at the turn of the nineteenth century, the processes of city development were accelerated and completely transformed by the introduction of the new technologies of the day such as the telephone and the telegraph.[1] This is a trend that continues even now, as the use of digital technologies permeates and shapes different aspects of city development (Audriac, 2005). Consider that when you book your hotel room in any modern city this year, you are likely to take availability of free high speed wireless Internet service for granted. This service would have been deemed a luxury, or simply not available even a few years ago.

I've made a choice to begin my discussions from a rather turbulent year in American history – 1968. It serves to establish a linkage between technological developments and societal developments in the United States over the past 40 years. In examining changes in information and communication technologies over this 40 year period, let's first look at the early years, 1968–1978.

2.2.1 Developing Technologies (1968–1978)

It is often stated that the key ingredients of the digital revolution are the personal computer and the presence of the Internet. For most of us, both these developments are a 1990s phenomenon. However, the seeds for these innovations were sown in the 1960s when the forerunner to the modern Internet was created by the Department of Defense through its ARPANET program. The first personal computers were introduced in the early 1970s. Subsequently, Graphical User Interfaces (GUIs) were developed. Early computing systems were clunky, unwieldy and expensive. They were also developed to serve the needs of powerful investors – almost every IT innovation of the 1960s was driven largely by military/national defense goals. In large part, the focus at the time was about efficiency and accuracy, that is to say, "how can we get computers to do things faster and more accurately than humans can"? In this "trickle down" model that would subsequently be mimicked by every new innovation, the development of information technologies moved from defense and national security arenas into the realm of public administration. Among the early adopters were governmental agencies that began to "computerize" their records in order to automate and expedite internal institutional obligations such as payroll and inventory management as well as customer-oriented services such as billing.

Around this time, the first Geographic Information Systems (GIS) emerged – GIS was a term developed by Roger Tomlinson, who designed the Canadian Geographic Information System (Tomlinson, 1987). Other individuals and agencies developed tools, and protocols to facilitate rudimentary spatial functions.[2]

In the 1970s, IT development and GIS development occurred separately in local governments; GIS was sometimes treated as a stepchild of larger IT initiatives. An exception to this norm was the development of the United States Census, which embraced GIS and developed the early protocols and standards to create street network and address files that allows computers to automatically search for and locate a particular address on a digital map.[3] Another early adopter of GIS was the US Geological Survey, the nation's largest civilian mapping agency established in 1879. Working in partnership with the private sector, the USGS has consistently created and assembled mappable data about a variety of urban and natural attributes (Fig. 2.1).

2.2.2 Developing Software, Data, and Applications (1978–1988)

In the 1980s, personal computers and software to serve applications needs began to emerge. Although these computers and software programs still served an elite market, users were able to acquire and use these technologies to serve everyday needs. Spreadsheets, relational database systems, and word-processing applications became popular around this time. At the same time, GIS users too continued to evolve and grow – adopting and adapting other emergent technologies such as the use of remotely sensed data. The major drivers of GIS applications development in

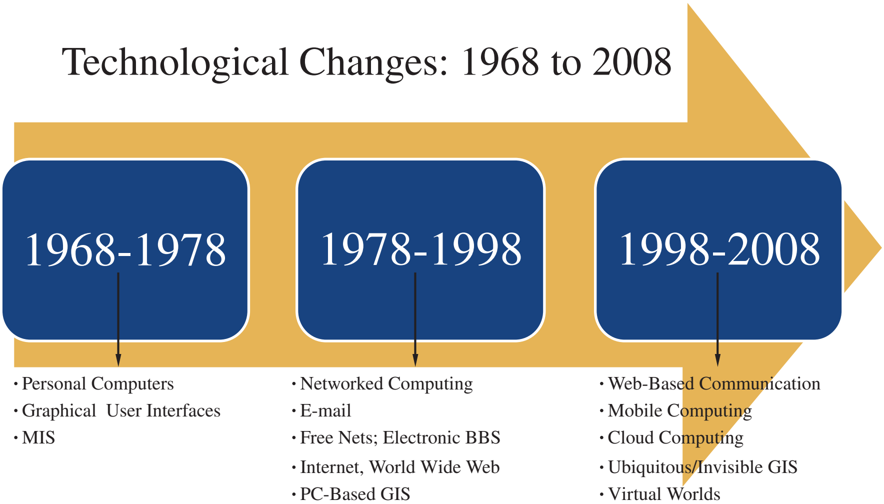

Fig. 2.1 Technological changes 1968–2008

the USA in the 1980s were the science agencies (NASA for example), while the main users were the utility companies and forestry sectors.

The notion of using GIS to support urban planning and management issues gradually emerged as the adoption and use of GIS among local governments began to spread. Huxhold (1991) was one of the earliest research-oriented practitioners who appreciated the value and role that information played within urban decision making processes. As he developed and managed spatial technologies for the City of Milwaukee over a period of 15 years, he learned a lot about the potential uses of GIS to address urban problems. Some of the highlights of his work include the development of maps to better understand the distribution of liquor licenses through the city and the identification of the worst landlords in the City "the dirty dozen".

Huxhold, like the authors of the URBIS study[4] (Kraemer, King, Dunkle & Lane, 1989) discovered that in government, managers exerted considerable influence in determining how data and information was collected, analyzed, and used. Thus, Huxhold concluded that the data and information needs for an organization focused on policy formulation were likely be substantially different from the needs of an organization intent on providing efficient services. For example, policy makers are likely to require integrated information that links the work of different departments; information that allows them to answer complex questions. Whereas, an organization primarily focused on efficient service delivery, is more likely be concerned about the accuracy of information it maintains, as well as the cost of its maintenance.

Huxhold discovered that while the potential of technology (GIS) use at the policy or decision-making level is high, the actual use of technology (GIS) in city government, as exemplified by the City of Milwaukee occurred through the automation of routine operations, that is, the computerization of tasks previously performed manually.

In the first two decades after GIS developed as a separate field and discipline, the dominant adopters and users of GIS were government agencies, research centers and universities. Universities using GIS developed new analytical tools, better database management procedures, addressed problems with spatial geo-referencing, error modeling, data quality management, and feature generalization (e.g., Poiker, 1976).

During these two decades, ordinary citizens and their more organized surrogates (community-based organizations), energized by earlier anti-war and civil rights movements, gradually redirected their energies to addressing environmental and public health concerns. As citizens mobilized to address issues of concern to the public at large, the government enacted laws to ensure that any project or activity receiving federal funds would specifically examine social, economic, and environmental impacts.[5] In most of these situations, the analyses were run by experts politically allied with the community cause.

2.2.3 Being Connected – Anywhere, Anytime (1988–1998)

Although the idea of a global network to electronically link all computer users had been around for a while, the electronic superhighway came closer to being a reality in the early 1990s. The digital revolution of the early 1990s was full of hype and unbridled hope. In particular, proponents of the information technology paradigm argued that the world was being transformed by emerging technologies for the better. Negroponte's (1995) book *Being Digital*, a *New York Times* best seller, offered an optimistic vision of the future transformed by the power of digital information.

> Early in the next millennium, your phone won't ring indiscriminately; it will receive, sort, and perhaps respond to your incoming calls like a well-trained English butler. Mass media will be redefined by systems for transmitting and receiving personalized information and entertainment. Schools will change to become more like museums and playgrounds for children to assemble ideas and socialize with other children from all over the world. The digital planet will look and feel like the head of a pin. (Negroponte, 1995, p. 6)

At the same time, dystopian views about the dangers of high technologies were also expressed with equal aplomb. Many people invoked Orwell's classic novel *1984* warning us about the horror of surveillant media technologies. Others like Clifford Stoll in his book *Silicon Snake Oil: Second Thoughts on the Information Highway*, observed:

> The key ingredient of their silicon snake oil is a technocratic belief that computers and networks will make a better society, [that] access to information, better communications, and electronic programs can cure social problems. I don't believe them. There are no simple technological solutions to social problems (Stoll, 1995, p. 50).

An entire genre of literature about how to cope, that is to say, how to survive life in a permanently networked society began to emerge during this time (Shenk, 1997). Critics also argued that the digital revolution contributed to the isolation and marginalization of individuals and communities. This is because access to the internet is not evenly distributed. The term of choice to describe disparities in access is the "digital divide". This divide has been identified both in terms of lack of access to the basic tools (Norris, 2001) and as well as skills to use the technology (Mossberger et al., 2003). In earlier days, connectivity (putting the fiber-optic network in place) was conceptualized as a barrier to access,[6] although with the development of wireless broad band networks, the problems of connecting remotely situated end users has largely been overcome in the United States. Yet, the data from the Pew Internet and American Life Project reported by Mossberger et al. (2008) suggests that many Americans (approximately 27% according to the report) are not connected to the Internet for one reason or another and cannot participate in our brave new digital world.

These revelations broadened discussions about access to consider the social and institutional contexts that can either provide or impede access to information. Likewise, the ability of the individual or group to be able to interpret and thereby use the information they have managed to obtain (sometimes discussed under the rubrics of digital literacy or digital citizenship) are also topics that concern practitioners and policy makers, who want to promote easy access to planning-related information. Presently, discussions about access includes topics such as freedom of information, individual privacy rights, the commodification of information, data quality, data sharing standards, spatial literacy, and the role of intermediaries (e.g., non-governmental organizations) in assisting the public to gain access to information (Craglia & Masser, 2003; Ramasubramanian, 2007).

The GIS discipline and profession benefited from the rapid growth of personal computers, improved analysis software, and the availability of census data. As GIS applications grew and expanded, complexities associated with their adoption and use became apparent. In response to the need for basic and applied research about GIS development, a consortium of universities established the National Center for Geographic Information and Analysis (NCGIA)[7] in 1989. The center began organizing its research efforts through a series of research initiatives. Predictably, the earliest research initiatives addressed technical issues (accuracy, data quality, and spatial decision support) but the consortium gradually began considering a broader set of issues including the sharing of geographic information (Initiative 9); user interfaces for GIS (Initiative 13), and collaborative spatial decision-making (Initiative 17).

NCGIA Initiative 19 sought to investigate the "social implications of how people, space, and the environment are represented in GIS". The "GIS & Society" initiative grew out of a 1993 workshop in Friday Harbor, Washington. A community of scholars began investigating the consequences of rapid adoption and use of high technologies and their impacts on the lives of ordinary citizens. John Pickles, in a seminal 1995 book, discussed the social implications of GIS charging the GIS community to pay close attention to the built-in biases that shaped GIS adoption and use. Wegener and Masser (1996) proposed alternative scenarios of the world in the year 2015 depending on the models of GIS technology diffusion and technology policies that were adopted in the 1990s. Their fears about the dominance of the market (the market scenario) have largely not come to pass, at least in the United States. It is reassuring to note that a lot of public information still remains accessible to the public, in part because of the assistance of the market.[8]

At the same time, electronic community networks grew rapidly, helping to link ordinary citizens. IT practitioners frequently use the term "community networks" to refer to electronic networks designed to foster community and advance social goals such as building community awareness, encouraging involvement in local decision making, or developing economic opportunities in disadvantaged communities (Schuler, 1997). Howard Rheingold (1993), based on evidence gathered from one of the world's earliest electronic communities – the Whole Earth 'Lectronic Link (the WELL) observed that computer-mediated communications provided *social network capital* (the capacity to meet others with similar interests, the readymade community), *knowledge capital* (the capacity to get on the network and ask for help on a range of subjects from a gathered community with diverse experience and expertise), and a sense of *communion* (being supported emotionally by an invisible community).

Anne Beamish, as early as 1995, organized these non-profit community networks into four broad categories:

- Freenets (loosely organized, community-based, volunteer-managed electronic network services. Freenets provide local and global information sharing and discussion at no charge to the Freenet user or patron).
- Bulletin Board Systems (typically stand-alone systems which focus on local information and discussion in a particular neighborhood or part of a neighborhood accessible only to those users who can connect to a particular computer by modem).
- Government sponsored networks (city-wide networks that are sponsored by state or local governments whose primary purpose is to make city records and municipal information available to all residents).
- Wired cities (a community or a city within which all kinds of electronic communications services are available to households and businesses or any experiment or project involving the provision of information and communication technology to households and businesses).

Schuler (1997) argued that network users would form an on-line community and behave as they would in a real world community, i.e., individuals and organizations would come and go as they pleased and participate to the intensity they desired; and in turn this participation would depend on their needs and interests as well as the openness, policies, politics, and spirit of the on-line community.

2.2.4 Creating Empowered Netizens (1998–2008)

Since 1998, the changes that have occurred in the world of computing and the development of new technologies have been mind-boggling. In 1994, the futurist John Naisbitt made a far-reaching pronouncement. He argued that the functional differences between the telephone, television, and personal computer would disappear (Naisbit, 1994). This phenomenon has largely come true. In 2008, the computer behaves like a television, a social networking portal, a mobile workspace, and when necessary, serves as a telephone with an optional video display. The costs of personal computers have declined further, and most people now use their mobile telephone to organize information, communicate via email, send pictures and video links to friends, listen to music, and find their way around town. Digitally empowered citizens are at the forefront of community organizing; social networking sites like MySpace and Facebook allow for multiple opportunities where online activities can spill over into the real world. Individuals using services like Twitter can provide news and information in real-time about on-going events at a pace comparable with, or better than conventional news media. In the next section, I will trace the evolution of Public Participation GIS (PPGIS) over this time period.

2.3 The Evolution of Public Participation GIS

Public Participation GIS is an awkward phrase that has come to encapsulate the intersection of community interests and the widespread adoption of GIS technology. As one reviews the social history of the field, it is interesting to note that the name choice PP+GIS emerged from the planning field[9] (Obermeyer, 1998). The early origins of PPGIS were focused on harnessing the capacities of GIS to serve community interests, while remaining cognizant of the potential limits of the technologies themselves. Even a recent exhaustive review of the subject (Sieber, 2006) failed to provide a clear definition of PPGIS, opting instead to characterize PPGIS as a field or a broad umbrella of practice activities, emerging from various disciplines and driven by disparate agendas. We can safely state that PPGIS is a term used to describe a range of participatory planning activities that are supported or enhanced by the use of digital tools such as GIS maps.

Despite ambiguity about its nomenclature (fortunately a distracting discussion that is limited to the academic enterprise), PPGIS adoption, or in other words, the use of GIS tools and techniques to solve a variety of community-oriented problems grew rapidly in the early 1990s. This spurt in GIS activity at the grassroots can be correlated with wider technology growth trends of the 1990s. In the United States, this growth spurt was directly and indirectly supported by the investments made by the federal government in the areas of education, health care, business, commerce, and environmental management, and in community development.[10] For example, between 1995 and 2000, US Department of Commerce[11] funded over a hundred projects including demonstration projects,

Table 2.1 IT/GIS applications for low-income communities

Application	Function	Primary/ secondary sites
Community Assessment Database	PC-based community development data sets; property/ infrastructure inventory	Community agencies; community development corporations; universities
Community Internet Server	Free-net provision of e-mail, telnet, ftp, Internet access, etc., for citizen use	Homes; community-based organizations
Interactive Crime Response Network	Electronic network to coordinate crime monitoring and public safety planning	Homes; community policing offices; community agencies
Information Kiosks	Single or multi-purpose electronic kiosks for information dissemination/ communications	High volume public access points
Community Health Station	On-line information on health promotion/ prevention for self-diagnosis/ referral	Community-based organizations; health and social service agencies

community networking projects, and infrastructure development projects all designed to improve electronic telecommunications and showcase the advantages of connectivity.

One of the earliest descriptions of IT applications designed to serve "low income" communities came from Richard Krieg (1995). Although the "PPGIS" terminology was not used in his survey, many of the applications and functions listed are examples of community-oriented spatially referenced information systems. At the time of Krieg's survey, many providers and consumers of information strove to bridge the digital divide by providing free or low cost access to e-mail and the Internet. Other applications required users to be at particular physical locations to access services (e.g., the offices of community agencies, public libraries, and other high volume access points). An overview of some of these applications is provided in Table 2.1.

While technology (the hardware) was seen as a primary barrier to bridging the digital divide, other barriers such as software, technical and literacy skills, as well as access to data were beginning to be recognized. The federal government's investment in technology access projects during this period cannot be underestimated. At the same time, community-based organizations in the United States were being challenged to take on additional service provision and advocacy responsibilities with limited resources. Creative community-based organizations were quick to explore the potential of emerging technologies to help achieve organizational goals. In some instances the traditional funders of community-based organizing and development provided funding for technology-related projects, while industry provided hardware and software donations.

By 1995, the US Department of Housing and Urban Development was requiring community-based organizations to develop applications to demonstrate community need in order to be eligible to receive block grant funding.[12] Community organizers discovered that by mapping census data and integrating it with additional information gathered from other city and county sources, they could begin to create a socio-spatial narrative that was more evocative to describe neighborhoods in need. Thus, the mid-1990s efforts tended to map misery (e.g., crime, socioeconomic deprivation), with the goal of drawing precise geographic boundaries to target areas of greatest need. However, they spurred a culture of data-driven analysis of social issues that facilitated data gathering and data integration. Many of the nation's smaller cities received additional support for these efforts from philanthropic institutions[13] and research policy institutes.[14] The planning literature cites a plethora of small community-focused GIS activities during this time (e.g., Myers et al., 1995; Talen, 2000).

In 1997, an ESRI[15] publication, *Zeroing In: Geographic Information Systems at work in the community* (Mitchell, 1997) catalogued the use of GIS for a variety of social applications, including emergency dispatch, finding funding to build low-cost housing, tracking drug activity, and managing urban sprawl. Each example described a simple story, with readily identifiable and manageable problems and a structured set of solutions. A collection of case studies, including some that explicitly discuss PPGIS work in US community-based organizations, can be found in a compendium, *Community Participation and GIS*, edited by Craig, Harris and Weiner (2002).

In the nation's larger cities, comprehensive community building initiatives also encouraged data collection, integration and a managerial approach to social problem solving. Community-based organizations began providing access to real property and infrastructure inventories on stand-alone computers in order to better understand the dynamics of neighborhood change. Using an indicators-based approach, community groups were able to target physical interventions that were intended to address social problems (e.g., removing abandoned/boarded up houses to reduce risk of arson or drug crime). These systems eventually evolved into Neighborhood Early Warning Systems which were adopted in many cities such as Minneapolis, Chicago, Philadelphia and Los Angeles among others (Snow, Pettit & Turner, 2004).

Sawicki and Peterman (2002) using data from a 1998 national survey designed to assess the extent of PPGIS practice reported that a wide range of nonprofits, some affiliated with universities, as well as some government agencies were engaged in some kind of PPGIS activity. The 18 university affiliated projects identified in the Sawicki/Peterman study included centers that provided mapping and technical assistance services such as the East St. Louis Action Research Project[16] (ESLARP), and Neighborhood Knowledge Los Angeles[17] (NKLA). By this time, the web had matured to support internet-based data delivery. Government agencies were just beginning to get involved in data provision and dissemination via the web, with the lead being taken by federal departments such as the US Census Bureau, the US Department of Housing and Urban Development, and the Environmental Protection Agency. These national initiatives had their counterparts at the state and local levels of government. Many cities launched data delivery services with support from local and regional partners. One such example is the

Boston Foundation-funded project called The Boston Indicators Project. As the project's tag line – measuring what we value – suggests, this on-going initiative "seeks to democratize access to information, foster informed public discourse, track progress on shared civic goals, and report on change in 10 sectors" (Boston Foundation, 2009).

2.4 Changes in PPGIS Use and Planning Practice

During the 15-year time frame that participatory planning using digital technologies have been in vogue, many of the benefits of digital connectivity and access to geo-spatial technologies are associated with social learning. PPGIS advocates have emphasized "jumping scale", as one of the benefits of using GIS to address the needs of marginalized communities. It is argued that by allowing end users to explore issues at different spatial and temporal scales, these users were likely to be freed from the limits of their particular marginalized positions. It was also argued that by changing the units of analysis, new understandings and new alliances could be established and brought to bear in the problem solving process. It must be noted that while Rheingold (1993) and others in the digital networking world emphasized individual-to-individual and individual-to-group connections, those within community organizing/development world focus on community-to-community connections (Agre & Schuler, 1997).

In 2007, the goals of individual learning, development and empowerment have largely been achieved because spatial technologies have been more seamlessly integrated within ubiquitous applications. At present, even naïve users can explore a highly context-sensitive, communicative visualization that can provide multimedia experiences in real time. If access to information can be equated to empowerment, then, "netizens" have multiple opportunities to access information that reflects different perspectives and viewpoints. Individuals can take advantage of 3D interactive visualization tools such Google Earth™ to add data and information about particular issues without having access to complex GI technologies or software. These developments confirm and document another benefit emphasized by PPGIS advocates — that the technologies allow end users to participate in the production of knowledge, rather than remaining passive consumers of information (Gaventa, 1993; Ramasubramanian, 2004).

Individuals with minimal technical knowledge can now add ideas, comments, pictures, maps, and other kinds of data and information to enrich on-going conversations about a variety of social issues. For example, in an on-going fracas that pits community activists in Brooklyn, New York, against mega developers promoting a new stadium and high-rise residential complex in downtown Brooklyn, community activists have used interactive 3D visualization tools to "show" how the scale of the proposed development conflicted with the existing character of the neighborhood.[18]

The results are more mixed when the goals are neighborhood or community empowerment. Nonprofit organizations[19] now play an important role in facilitating PPGIS efforts. Local data providers include community-based service providers and advocacy groups. These organizations often create customized data sets that organize information relevant to a particular population subgroup (e.g., caregivers of young children) or by geographic boundaries that are more easily understood by ordinary citizens (e.g., neighborhood areas rather than census tracts). Community data centers[20] are also repositories of rich local and contextual knowledge. Community archives often include geo-referenced information that may not be available in official records. Examples of such local information include oral histories, drawings, sketches, photographs, as well as video and film clips.

While there is clear evidence that the stakeholders who got involved on behalf of the neighborhood are transformed through and because of their activism, it is difficult to assess spillover effects. Specifically, it is not clear whether community members who were not directly involved feel a sense of empowerment although they may have been among the ultimate beneficiaries of citizen activism and community-based planning. Furthermore, in documenting and evaluating spillover effects, it is difficult to determine the unique contributions of geo-spatial technologies.

The results of technology adoption to address a range of social issues are clear – in advocacy and participatory planning work, GIS is now part of the organizing arsenal required to challenge "official" planning decisions and policies, often generating new data and information. These new forms of evidence have served well the quest to energize citizen activism at the neighborhood scale. Yet, the results are not as clear when we seek to understand the transformative and collective impacts of participatory projects that used GIS, perhaps because published narratives of Public Participation GIS (PPGIS) adoption and use often focus on the particular case (e.g., Craig et al., 2002), placing little or no emphasis on the larger planning frameworks that govern technology adoption and use.

Furthermore, there are many activities that carry the PPGIS label causing great confusion among practitioners about what constitutes a PPGIS activity. While there are many researchers developing tools and methods to support PPGIS work (e.g., Lowry et al., 2009), there is no clarity about what ideal PPGIS activity should look like. In Chap. 3, I take on this challenge.

Notes

1. The adoption and diffusion of technological innovations into society's mainstream typically takes the form of an S-curve (Rogers, 1995), when there is enough of a critical mass of people (users, if you will) who have adopted a particular technology.
2. For a good historical overview of GIS, read Tim Foresman's (1997) book.
3. See, The GIS History Project archives at: www.ncgia.buffalo.edu/gishist/.
4. Ken Kraemer and John King of the Public Policy Research Organization at the University of California at Irvine, along with other colleagues, conducted detailed case studies of local

governments in seven cities in order to understand the complexities of adoption of information technologies. The Urban Information Systems (URBIS) project, begun in 1973 was one of the most comprehensive case studies of local governments' use of information technologies. The study sought to identify those policies (related to the management of information systems) that were most conducive to the adoption and utilization of information technologies within the organization, treating the organization as a comprehensive political and administrative system.

5. For example, The National Environmental Policy Act of 1969 (NEPA) is federal government legislation that requires a thorough analysis of the impacts of a project or activity receiving federal funds and requires consideration of social, economic, and environmental concerns.
6. The *universal service* provisions of the United States communications laws were originally intended to provide affordable local telephone service. The Telecommunications Act of 1996 expanded these provisions to include access to advanced telecommunications services at discounted rates to all communities, with a special focus on elementary and secondary schools, libraries, health care providers, as well as rural or isolated populations. For more information, see the Federal Communications Commission's website: http://www.fcc.gov/wcb/tapd/universal_service/
7. The National Center for Geographic Information and Analysis (NCGIA), Maine, the center is a multi-institution, multi-disciplinary research consortium dedicated to basic research and education in GIScience and related technologies. University of Buffalo: www.ncgia.buffalo.edu; University of Maine: www.ncgia.main.edu; University of California, Santa Barbara: www.ncgia.ucsb.edu
8. For instance, http://www.zillow.com/webtools/data-resources/
9. Obermeyer credited Dr. Xavier Lopez, then a student in Orono, Maine for suggesting this term; this was confirmed by Dr. Lopez through personal communication with Dr. Ramasubramanian in 2008.
10. Community development has been defined as a process "designed to create conditions of economic and social progress with the active participation of the whole community and with the fullest possible reliance on the community's initiative" (Rothman, 1974, cf. Levine & Perkins, 1997, p. 336).
11. The Telecommunications and Information Infrastructure Assistance Program (TIIAP), one of the programs of the National Telecommunications and Information Administration, is authorized by 47 USC-390-393A (1991) to provide resources to be used for the planning and construction of telecommunications networks for the provision of educational, cultural, health care, public information, public safety or other social services. It morphed into the Technology Opportunities Program (www.ntia.doc.gov/top/)
12. The Community Development Block Grant (CDBG) Program is among one of the oldest programs of the United States Department of Housing and Urban Development (HUD). It is a very flexible program that provides annual grants for a wide variety of activities related to physical planning including property acquisition, demolition, rehabilitation, construction of buildings, and economic development activities. CDBG funding mandates a high degree of citizen participation and an additional obligation that no less than 70% of CDBG funds are used for activities that benefit low-and moderate income persons. Additional information about the program is available at: http://www.hud.gov/offices/cpd/communitydevelopment/programs/index.cfm
13. Annie E. Casey Foundation's KIDS COUNT initiative is a national and state-by-state effort to track the status of children in the United States. The first national KIDS COUNT data book was published in 1990. For more information, see http://datacenter.kidscount.org
14. The National Neighborhood Indicators Partnership is led by The Urban Institute. The project began in 1996, funded by the Annie E. Casey Foundation and the Rockefeller Foundation. For more information see: http://www2.urban.org/nnip/index.htm
15. According to the company's website, ESRI was founded as Environmental Science Research Institute (ESRI) Inc., in 1969. A global company, headquartered in Redlands, California,

ESRI has been critical to the creation of a strong GIS user community in the United States. Additional information can be found at: www.esri.com

16. East St. Louis Action Research Project www.eslarp.uiuc.edu
17. Neighborhood Knowledge Los Angeles. nkla.ucla.edu was created in 1998 with a total project cost of over US $1 million with support from multiple sources with over half the support coming from the Technology Opportunities Program of the US Department of Commerce.
18. Barkey (2006) and Keegan (2006).
19. Neighborhood Data Center, a program of the NonProfit Center of Milwaukee, Inc., http://www.nonprofitcentermilwaukee.org/datacenter
20. Greater New Orleans Community Data Center, http://www.gnocdc.org/

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