The Issue of Access: An Assessment Guide for Evaluating Public Participation Geographic Information Science Case Studies

Melinda Laituri

Abstract: *This article examines how technology mediates access to geographic information for public participation. Access consists of several components: context, connectivity, capabilities, and content. An assessment guide is introduced that defines a series of continuums for evaluating case studies that involve public participation and geographic information systems. The purpose of this article is to introduce a preliminary guide for assessing existing case studies to facilitate a dialogue for evaluating public participation, access, and geographic information systems. Seven case studies are examined.*

Introduction

Public Participation Geographic Information Science (PPGIS) is acknowledged as an important GIS activity but with little formal understanding of the theories and methodologies that researchers and participants have used. A Specialist Meeting held in Spoleto, Italy discussed trans-Atlantic PPGIS activity. One of the issues identified at this meeting was the need to assess PPGIS activities and, more specifically, to examine existing case studies to determine what lessons have been learned, what types of case studies have been undertaken, and where the gaps exist in these case studies. Brandt (2002:356) raised a series of issues with regard to PPGIS and stated, "It may not be appropriate to compare apples and oranges, but as advocates for more effective use of information and GIS tools we should be seriously critiquing the whole fruit basket of alternatives as they proliferate."

This article presents a preliminary guide for assessing existing case studies in order to facilitate a dialogue to understand PPGIS projects to date. It is important to note that the initial ideas for this guide were discussed and developed amongst a group of scholars at the Spoleto meeting. In this article, I am representing some of their ideas and building on this joint effort. This guide is not theoretical in nature; it is an assessment tool to create an empirical basis for the evaluation and comparison of case studies through the identification of common characteristics across different contextual settings. This article is not an exhaustive examination of PPGIS projects, but a reflective exercise to implement this guide. Seven PPGIS case studies in which I have participated are examined.

PPGIS is the confluence of social activity (participatory activities, grassroots organizations, governmental decision making, the Internet) and technology (computers, hardware, software, digital information, the Internet) in specific places – grounded geographies (Niles and Hanson 2001). Nascent literature on PPGIS has emerged from the activities of many researchers, some of which can be found in the resulting articles from the National Center for Geographic Information and Analysis (NCGIA)-sponsored Varenius initiative (Craig et al. 1999), the NCGIA Initiative #19 GIS (Harris and Weiner 1996), and Society and other meetings such as the European Science Foundation/National Science Foundation (ESF/NSF) Workshop on Access to Geographic Information and Participatory Approaches Using Geographic Information (Craglia and Masser 2001). In Community Participation and Geographic Information Systems, Craig et al. (2002:8) identified "PPGIS as a broad tent with multiple meanings and a global reach" made up of "emerging forms of community interaction with GIS that are linked to the social and geographic context of PPGIS production and implementation."

Geographic Information Science (GIS) is one aspect of several compatible and linked technologies (remote sensing, global positioning systems, and satellites) that are part of the "digital revolution." The application of these technologies combines the complexity of the physical landscape with the human strata in the form of information that may be useful to a particular community or locality, a state or province, a nation, or even the world (e.g., global climate change). Sophisticated technologies create their own set of unique access issues of which power, education, and resources are of special interest.

Methods of participation in PPGIS are often circumscribed by technologically imposed structures. For example, digitally available data can be found on the Internet but may need to be downloaded and processed before viewing and analyzing in a compatible software package. For such projects, experts may need to be hired to create a database and conduct analysis. However, the coupling of public participation and GIS is a process that develops a synergy of its own where new forms of participation and empowerment can extend beyond the technological and digital environments. Access is more than the material connections to the virtual world. Access becomes a matter of skill, contacts, and education. Therefore, technology mediates access and influences participation.

Table 1: The components and continuums that can be used as a relative assessment tool for existing PPGIS projects.

Components	Continuums of Key Words
1. Context: a. Purpose	Simple → Complex project Day-to-day decisions → Strategic outcomes
b. Stakeholders	Marginal → Mainstream → Elite
c. Linkages	Single → Multiple agencies No trust → Trust
d. Unit of Analysis	Local → Regional → Global
2. Connectivity: a. Policies	Donations → Grants → Funding
b. Infrastructure	Urban → Rural No technology → Best technology
3. Capabilities: a. Basic literacy	Less educated → More educated
b. Computer literacy	Novice → Training → Education
c. Spatial literacy	Novice → Training → Education
4. Content: a. Data availability	Information rich → Information poor
b. Data types	Public data → Sensitive data New data → Inherited or existing data Qualitative data → Quantitative data

Numerous case studies exist that exemplify PPGIS.

Access Assessment Guide

Access can be defined as a complex set of continuums manifested by a multifaceted Digital Divide of "haves" and "have nots." These continuums address aspects of the PPGIS process focusing on access and technology, which is not exhaustive of the many different aspects of PPGIS. The United Nations Ministerial Declaration on Information Technology (2000) identified three aspects of information technologies in general that address issues related to access. I have adapted these and added a fourth for PPGIS: context, connectivity, capabilities, and content. These components are made up of a set of characteristics that can be understood as a series of continuums defined by key words (Table 1).

This assessment is designed to identify how technology mediates access to PPGIS and focuses on technologically imposed structures: the physical infrastructure, the basic skills needed to conduct GIS, and the data.

1. "Context" is the setting that determines how technically imposed structures are accessed based upon the purpose and participants in the project. Context includes:
   a) Purpose: What is the problem or issue being addressed?
   - Simple → Complex Project: Does the problem concern simple single issues or does it address complex multiple issues?
   - Day-to-day decisions → Strategic outcomes: Does the project address day-to-day decisions or strategic outcomes over the long term?

   b) Stakeholders: Who are the participants practicing PPGIS?
   - Marginal → Mainstream → Elite: The relationship that a group of people have to the political/social process reveals how integrated that group is in the political process and how much power they have. Is PPGIS an avenue for participatory democracy?

   c) Linkages: What linkages, partnerships, and relationships exist between the participants?
   - Single → Multiple agencies: Does it address multi-agency concerns? In the case of natural resource management, PPGIS demands integration across disciplines as well as across agencies.
   - No trust → Trust: Do the new interactions between different participants mean that trust must be built or does expertise, professional background and credentials satisfy the participants?

   d) Unit of Analysis: How is place defined?
   - Local → Regional → Global: What is the unit of analysis?

2. "Connectivity" identifies the technological infrastructure and the funding that is available for access to that infrastructure for PPGIS projects. Connectivity is made of two critical parts:
   a) Policies:
   - Donations → Grants → Funding: Explicit policies of governments may exist to facilitate connections to remote and underpopulated areas and to provide oversight, guidance, and assistance to ensure the participation of markets and the private sector in this process. Generally, policies are not implemented unless there is funding available which may be in the form of donations, grants, or as an explicit line item in a budget (funding).

   b) Infrastructure: An outcome of these activities and polices is the intersection of cyberspace and physical space – the materiality of cyberspace that is made up of points of access, the actual wires and links in the real world, as well as a set of linked technologies that provide access: modems, mobile phones, or mobile Internet.
   - Urban → Rural: Is the project in an urban, a suburban, or a rural setting? An unequal distribution of cyberspatial connections and bandwidth exists, particularly in rural areas and inner cities (Niles and Hanson 2001).

- No technology ® Best technology: To what extent do project participants have access to the fundamental technology or state-of-the-art technology?

3. "Capabilities" determine how participants will interface with the technology. Capabilities are made up of three levels of literacy:
   a) Basic literacy (Less educated → More educated) identifies the educational level of the participants.
   b) Computer literacy (Novice → Training → Education) includes the ability to operate and maintain computers. At its most basic, computer literacy means an understanding of keyboards, logging on, and basic skills in pointing and clicking a mouse. A subset of computer literacy is Internet-literacy, which means an understanding of the virtual world created by computer software programs and the ability to navigate in cyberspace: operating systems, web browsers, search engines, key words, and Web pages. Training is important for technology transfer and refers to government- or vendor-sponsored training programs. Education refers to individuals with degrees in computer science that may assist PPGIS projects.
   c) Spatial literacy (Novice → Training → Education) translates into conceptual access to understand the underlying grid imposed by cartography (coordinate systems), geodesy (datum's and projections), geospatial science (spatial analysis), and digital information (raster, vector, triangular irregular networks (TINs)) that includes terms generally not part of the everyday lexicon. In addition, it means understanding specialized software for GIS analyses, understanding digital data formats, and conveying results to different audiences. Experts may be needed to translate and transform information or training and education for the purposes of technology transfer.

4. Place-based "data" with local content are needed for many PPGIS projects. Content refers to data and information.
   a) Data availability:
   - Information rich → Information poor: One end of this spectrum is having the best available digital information to be used in a GIS. The other end is having little or no information. Are data available for place-based projects? Another important consideration is whether or not it is in the appropriate language. The information may be there, but not available to the potential users unless they have access to experts. 80% of Internet content is in English, of which one quarter of the world understands (Siefken 2000).
   b) Data types: The questions of a PPGIS project include a variety of different data types at different spatial scales and of varying vintages. These may include physical, cultural, social, and environmental data of both a qualitative and quantitative nature.
   - Public data → Sensitive data: Public data refer to data that are available from governmental entities at little or no cost and may also include value-added data that can be purchased from a private vendor. Sensitive data refer to information that may be considered sensitive or sacred. Some projects may use both types of data and will need to determine methods to protect sensitive information and integrate with a larger database.
   - New data → Inherited or existing data: Integration of data types involves the use of new data (remotely sensed images) or the creation of new data (use of a global positioning system to collect field data) with inherited or existing data (topographical maps).
   - Qualitative data → Quantitative data: What happens to information that does not lend itself conceptually or easily to a digital environment? Cultural concepts are difficult to transform across the boundaries of language and technology. Alternatively, quantitative data fit into the framework of a GIS. Most biogeophysical data are quantitative.

Access can be analyzed through an assessment of these components: connectivity, capabilities, content, and context. These continuums provide a guide for a relative comparison of case studies. Case studies are examined and characterized to begin to assess the body of work that comprises PPGIS case studies.

Case Study Assessment

These projects represent complex management situations that involve a cross-section of participants seeking to create bottom-up solutions to particular problems. A common characteristic is the notion that information access and assessment will enhance empowerment and consensus building amongst participants. The projects represent the integration of multidisciplinary, multifaceted, multi-agency issues that often focus on regional issues (Table 2).

The assessment guide is used as a calculus to evaluate case studies through a comparison of relative location on a series of continuums. The purpose of this exercise is to test this guide and to consider improvements and how they might be calibrated to add other case studies to begin the process of identifying the types of PPGIS projects that have been conducted to date.

This is a small subset of the numerous case studies that have been conducted for PPGIS. It focuses on issues related to access, but it is not exhaustive of these issues. It does not consider methodology or levels and types of participation – these are important aspects that should be added to the assessment guide.

Context

"Context" provides the setting in which PPGIS projects take place that will influence how and what types of technology are accessed (Table 3). The purpose and unit of analysis are defined by the stakeholders with assistance from the contacts, networks,

Table 2: The case studies and the purpose of each is described.

[a] These projects are described on their Web sites.

[b] These case studies are described in detail in Laituri, M., 2002, Ensuring Access to GIS for Marginal Societies. In Craig, W., T. Harris, and D. Weiner (Eds.), 2002, Community Participation and Geographic Information Systems (London: Taylor and Francis), 270-282.

[c] This project is described in Laituri, M., R. Hay, and G. Saxe, 1991, Generation of a GIS Database in a Transboundary Setting: Ambos Nogales. In: Proceedings of Arizona Hydrological Society Fourth Annual Symposium, Survival in the Desert: Water Quality Issues, 30-35.

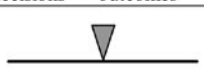
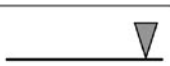
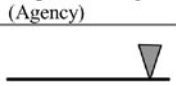
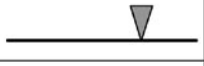
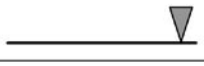
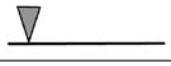
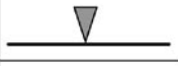
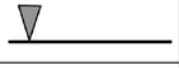
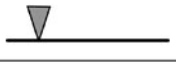
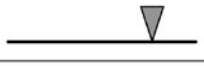
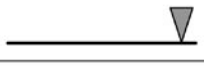
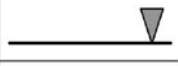
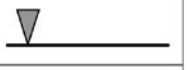
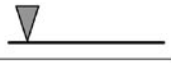
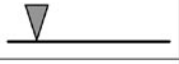
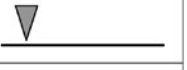
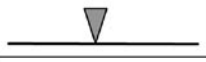
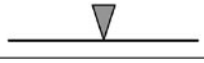
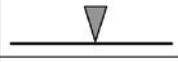
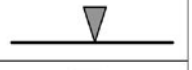
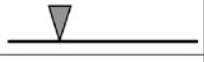
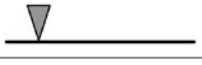
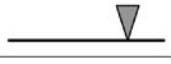
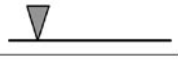
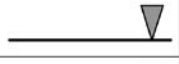
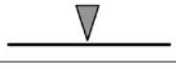
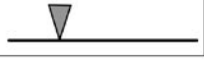
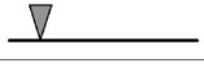
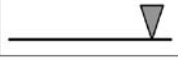
Case Study	Description
Colorado–Big Thompson Watershed Forum (C-BT)a http://btwatershed.org/Default.htm	The Watershed Forum is comprised of multiple governmental agencies at the federal and local levels, along with interested community members to develop a cooperative water quality information system that standardizes water quality monitoring between multiple agencies in the Big Thompson Watershed. A GIS was created to display land use and water quality information.
Wind Rivers Indian Reservation (WR)b	The Wind Rivers Indian Reservation has a state-of-the-art GIS. Methods were developed in conjunction with university researchers to create a cultural database of water resource management activities to enhance the existing database.
Nogales, Arizona–Sonora Water Quality Project (Nog)c	A consortium of federal, state, and local government representatives, local non-governmental organizations (NGOs), and university researchers formed to address bi-national water quality and water resource management issues across the international boundary. A bi-national water quality GIS was developed.
Maori Economic Development (MED) Project b	Local community representatives and university researchers developed a cultural database of resources for economic development of three communities in New Zealand. A GIS was developed that incorporated culturally sensitive information with existing resource data.
Northern Colorado Plateau Network (NCPN)a www.cnr.colostate.edu/research/ncpn_nps	A network of National Parks in conjunction with other local landowners and university researchers developed a water quality information database for designing a water quality monitoring project. A GIS was created of all existing water quality information with other GIS data layers, such as land use, land ownership, geology, and hydrology.
Larimer County–Colorado State University Partnership (LC)a	Eight on-line projects were developed by graduate students at Colorado State University in partnership with the Larimer County GIS Department. The purpose of the project was to utilize Larimer County data and develop methods for transferring information to the public. Projects include: identification and routing to recycling centers, access to bus routes for the elderly, fire hazard on the urban-rural fringe, and hiking, biking and skiing trails ranked by access and level of difficulty.
Poudre School District – Colorado State University Partnership (PSD)b www.cnr.colostate.edu/avprojects/csu-psd	Thirty-eight on-line projects were developed by graduate students at Colorado State University in partnership with the Poudre School District. The purpose of the project was to develop GIS products for teachers to use in the classroom to meet geography, science, and mathematics standards. Projects are designed for K-12 levels and cover issues from local to global.

and linkages with other participants and agencies. Context is a dynamic setting in that the participants and networks are in a state of flux, with new participants joining or others leaving the project. In addition, the project will evolve as considerations regarding data availability and focus of the project are defined and refined.

Simple projects are regional and focus on a single issue. The Colorado–Big Thompson Watershed Forum (C-BT) and the Northern Colorado Plateau Network (NCPN) are water quality monitoring projects. The Larimer County–Colorado State University Partnership (LC) and the Poudre School District–Colorado State University Partnership (PSD) are designed to facilitate the use of GIS data for public consumption through single applications. The participants are primarily members of the mainstream, with some representation from elite groups (e.g., elected officials and key decision makers). The relationship between participants is based on acceptance of expertise and credentials rather than building trust between cooperating groups. These projects have linkages with several other agencies, which may be due to the regional nature of the project where there exist many different jurisdictional boundaries.

The Wind Rivers Indian Reservation (WR), the Nogales,

Table 3: Context. This table defines the complexity of the PPGIS project, identifies the participants and linkages with other agencies and disciplines and considers the unit of analysis.

Case Study	*Components*					
	Context: Purpose	Stakeholders		Linkages		Unit of Analysis
	Continuums					
	Simple → Complex	Daily decisions → Strategic outcomes	Marginal → Elite	Single → Multiple (Agency)	No Trust → Trust	Local → Global
C-BT						
WR						
Nog						
MED						
NCPN						
LC						
PSD						

Arizona–Sonora Water Quality Project (Nog), and the Maori Economic Development Project (MED) are all complex case studies. The projects sought strategic outcomes for water resource management and economic development at the local level. The participants are members of what may be considered marginal social groups: First Peoples and Hispanics. Trust-building is an important component of these projects where professional expertise and credentials are not adequate. Personal relationships have to be developed.

Connectivity

"Connectivity" identifies the key elements of the technological infrastructure for PPGIS (Table 4). Not all PPGIS projects utilize all of the technology that informs GIS projects. However, for certain types of projects, access to this technology will be easier to obtain based purely on geography and the physical infrastructure already in place (Niles and Hanson 2001). Policies are another critical aspect of connectivity. Several federal agencies (the Environmental Protection Agency, the United States Department of Agriculture-Forest Service, and the National Park Service) have explicit policies that demand public participation and input into resource planning. These agencies have solicited grants for community projects, of which GIS may be an important tool.

While policies encourage public participation, the primary source of funding for these projects is through grants, donations, in-kind contributions, or some combination of all. The only project with explicit federal funding is the NCPN, where federal policies for water quality monitoring are well established. The LC and PSD projects began with educational grants from state agencies. Currently, there is little or no funding for these projects and all activities are through volunteer efforts. The WR and MED projects specifically focus on developing a cultural information database to be included in their projects. This focus does not fit into governmental agency solicitations, and alternative funding is sought from private foundations.

These projects represent a diversity of geographic locations. The WR and MED are located in rural regions. The NCPN operates on National Park Service lands far from urban areas. Aspects of the C-BT, LC, and PSD projects include the urban-rural or urban-wildlands interface. Nog is an urban project. The geography of access reveals a wide disparity between projects. The NCPN and WR are well connected regardless of distance from urban centers. The reason may be their close association with governmental agencies. The C-BT, LC, and PSD reflect the hypothesis of Niles and Hanson (2001) that infrastructure will reflect existing patterns of access to technology. These projects are headquartered in urban centers with access to bandwidth, modems, computers, and the Internet. The MED and Nog projects have no on-site infrastructure. Access was facilitated by the university participants at campus locations.

Capabilities

"Capabilities" refer to levels of literacy: basic, computer, and spatial (Table 4). Less education does not preclude little or no computer or spatial literacy. The importance of technology transfer for participants is revealed through the creation of training programs to learn GIS skills, which is an outcome of several of the projects. Access may be redefined during the PPGIS activity

Table 4: Connectivity and Capabilities. Connectivity addresses the materiality of cyberspace in terms of the physical infrastructure and funded policies of government and partnerships. Capabilities identifies the level of education people have access to in order to conduct the PPGIS project.

Case study	*Components*					
	Connectivity: Policies	Infrastructure		*Capabilities:* Basic literacy	Computer literacy	Spatial literacy
	Continuums					
	Donations → Funding	Urban → Rural	None → Best technology	Less → More educated	Novice → Education	Novice → Education
C-BT						
WR						
Nog						
MED						
NCPN		NPS Lands				
LC						
PSD						

as participants gain ownership of their projects through such training activity.

The Nog and MED projects have participants with less education and little or no computer and GIS experience. The C-BT, NCPN, LC, and PSD have access to adequate technology, higher levels of education, and participants with computer experience. Three projects, the WR, NCPN, and LC, have some level of spatial literacy through training and education. The WR is unique with lower education levels, but with participants with higher levels of training in both computer and spatial literacy. Training programs in GIS have resulted from the MED, C-BT, and PSD projects. Additionally, all projects have access to GIS experts to assist in technology transfer and GIS translation.

Content

"Content" refers to the data and information available for projects (Table 5). Data availability is a critical aspect of PPGIS. Data collection and creation can be costly. Projects that use existing digital data will develop faster than projects that must collect new types of data. Place-based data may not exist or may be at the wrong spatial scale for the analysis purposes of the project.

The C-BT, NCPN, LC, and PSD projects are information rich. They have access to and use publicly available data. Generally, they are dependent on existing data of a quantitative nature. The C-BT uses existing data to create basemaps, but collects new data for water quality monitoring.

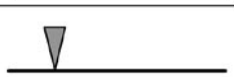
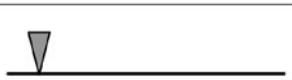
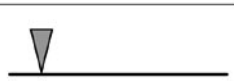
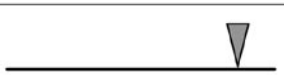
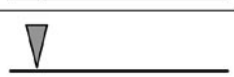
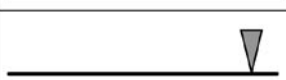
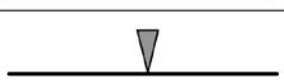
The WR, Nog, and MED projects are information poor in that their areas of study did not have much existing digital data. Also, the capture of cultural information for both the WR and MED studies meant the creation of new data of a qualitative and sensitive nature.

Conclusion

This assessment revealed some interesting trends. Inclusion of other case studies and additional continuums will improve this assessment and provide an empirical basis for understanding PPGIS projects to date. Continuums or spectrums are used to represent the complexity of these studies and to identify where dichotomies exist. Do the technologically imposed structures that are part of PPGIS reassert the digital divide? Those projects representing marginal members of society (WR, Nog, and MED) were the projects most in need of place-based information, new data, and education. The projects with strong linkages to government (LC, PSD, NCPN, and C-BT) had information, access to education, and data. How can researchers facilitate successful PPGIS projects in order to close the digital divide and not reinforce existing inequities?

Other researchers could use this tool to evaluate their case studies. However, the continuums need to be calibrated in some fashion – possibly through adding more key words to the continuums. Additionally, other continuums such as scale (coarse ® fine), data precision (precise ® vague), and networks (centralized ® decentralized) need to be identified that may better inform the state of the research and refine the evaluation. Types of methodology and levels of participation are other aspects of a PPGIS that this initial assessment does not include. However, to evaluate access this guide represents a starting point to addresses the salient issues of context, content, connections, and capabilities.

Table 5: Content. The final part of the assessment addresses the data available and the characteristics. The data represent a location. The format, type, and quality of the data all reflect how a location is understood and negotiated in cyberspace.

Case Study	*Components*			
	Content: Data Availability		Data types	
	Continuums			
	Information Rich → Information Poor	Public → Sensitive	New data → Existing data	Qualitative → Quantitative
C-BT				
WR				
Nog				
MED				
NCPN				
LC				
PSD				

PPGIS addresses complex and multifaceted problems. No consensus exists on the appropriateness of the set of indicators presented in this article. However, the assessment guide begins the process of reflection in PPGIS activities to address critical issues of access in the form of technology, data, and skills. Practitioners of PPGIS need to assess the state of the research to date to better inform future studies. Three fundamental questions must be addressed to understand outcomes of PPGIS: Who is informed? Who is empowered? Who benefits from the technology? These questions will assist in tracking the influence of technology to understand the embedded nature of inequities on the landscape and how technology facilitates them.

About the Author

Melinda Laituri is an Associate Professor at Colorado State University in the Forest Science Department. Her research interests include water resources management, risk, environmental equity, and geographic information systems.

Corresponding Address:
Melinda Laituri
Department of Earth Resources
Colorado State University
Ft. Collins, CO 80523
mell@cnr.colostate.edu

Acknowledgements

This article is a result of discussions at the ESF-NSF Workshop on Access to Geographic Information and Participatory Approaches Using Geographic Information, Spoleto, Italy, December 6-8, 2001. Special acknowledgments to the Left Hand Group: Laxmi Ramasubramanian, Meg Merrick, Steve Carver, Bob Rugg, Mario Boffi, Christie Drew, Erik de Man, and Franco Vico. Thanks to those anonymous reviewers who provided insightful comments to make improvements on an earlier draft.

This article is based partially upon work or participation in a workshop supported by the National Science Foundation under Grant No. 0098389 and the European Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the European Science Foundation.

References

Barndt, M., 2002, A Model for Evaluating Public Participation GIS. In Craig W., T. Harris, and D. Weiner (Eds.), Community Participation and Geographic Information Systems. (London: Taylor and Francis), 346-356.

Craglia, M. and I. Masser, 2001, Access to Geographic Information: A European Perspective. Workshop on Access to Geographic Information and Participatory Approaches Using Geographic Information, Spoleto, Italy, December 6-8, 2001. http://www.shef.ac.uk/~scgisa/spoleto/workshop.htm

Craig, W., T. Harris, and D. Weiner, 1999, Empowerment, Marginalization and Public Participation GIS. Specialist Meeting Report Compiled for Varenius: NCGIA's Project to Advance Geographic Information Science, NCGIA, University of California at Santa Barbara, February 1999.

Craig, W., T. Harris, and D. Weiner (Eds.), 2002, Community Participation and Geographic Information Systems (London: Taylor and Francis).

Harris, T. and D. Weiner, 1996, GIS and Society: The Social Implications of How People, Space and Environment are Represented in GIS. Scientific Report for NCGIA Initiative #19 Specialist Meeting, University of California at Santa Barbara, November 1996.

Laituri, M., 2002, Ensuring Access to GIS for Marginal Societies. In Craig, W., T. Harris, and D. Weiner (Eds.), Community Participation and Geographic Information Systems (London: Taylor and Francis), 270-282.

Laituri, M., R. Hay, and G. Saxe, 1991, Generation of a GIS Database in a Transboundary Setting: Ambos Nogales. In: Proceedings of Arizona Hydrological Society Fourth Annual Symposium, Survival in the Desert: Water Quality Issues, 30-35.

Niles, S. and S. Hanson, 2001, A New Era of Accessibility: Or Is It? Workshop on Access to Geographic Information and Participatory Approaches Using Geographic Information, Spoleto, Italy, December 6-8, 2001. http://www.shef.ac.uk/~scgisa/spoleto/home.htm

Siefken, S., 2000, UN High-Level Segment Targets Digital Divide. UN Chronicle 37(2), 29-31.

United Nations, 2000, Ministerial Declaration on Information Technology. http://www.un.org/esa/coordination/ecosoc/itforum/