Public Participation GIS: Applications in Community-Based Environmental Protection

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(Abstract)

Today with the maturation of technology, geographic information systems (GIS) provide governments, organizations, and policy makers with improved data and information for database management, visualization, and analytical tools in environmental planning. However, when taking into consideration the significance of public involvement in the whole planning process, traditional GIS has not fully incorporated the public needs into GIS technology or facilitated public participation. Some critics argue that the system is inherently authoritarian and techno-centric, excluding those who cannot access data and information. Recently planning scholars and GIS specialists have tried to close the gap between public participation in the planning process, and GIS technology and its applications. The concept of Public Participation GIS (PPGIS) is rooted in this trend.

The purpose of the paper is to compare and analyze different approaches of PPGIS to facilitate public participation in the community-based environmental planning and decision-making process. The paper investigates four case studies to compare. For the comparison and analysis, it uses frameworks consisting of three dimensions. Finally, the paper draws lessons from the implementation of PPGIS for the planning and decision-making process.

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Chapter 1. Introduction

Objective of the study

Today with the maturation of technology, geographic information systems (GIS) provide governments, organizations, and policy makers with improved data and information for database management, visualization, and analytical tools in environmental planning. However, when taking into consideration the significance of public involvement in the whole planning process, traditional GIS has not fully incorporated the public needs into GIS technology or facilitated public participation. Some critics argue that the system is inherently authoritarian and techno-centric, excluding those who cannot access to data and information. Recently planning scholars and GIS specialists have tried to close the gap between public participation in the planning process, and GIS technology and its applications. The concept of Public Participation GIS (PPGIS) is rooted in this trend. According to Krygier (1998), "PPGIS is conceived broadly as an integrative and inclusive process-based set of methods and technologies amenable to public participation, multiple viewpoints, and diverse forms of information."

The purpose of the paper is to compare and analyze different approaches of PPGIS to facilitate public participation in the community-based environmental planning and decision-making process. The paper investigates four case studies to compare. For the comparison and analysis, it uses frameworks consisting of three dimensions. Finally, the paper draws lessons from the implementation of PPGIS for the planning and decision-making process.

Scope and limitation

One of the purposes of PPGIS is to allow the public to gather, access, use, and analyze geographic information, data and policy using GIS for effective participation in the planning and decision-making process. Therefore the target users in this study are stakeholders or community members. They can be defined as those who are interested in, are affected by, or could affect activities related to Community-Based Environmental Protection (CBEP) efforts. They include individual residents and landowners, civic and religious organizations, businesses and industry associations, academic institutions, and environmental and conservation groups. This paper defines "community" as places and people that are associated with environmental issues (U.S. EPA, 1999). Community includes components and attributes of social interaction, common ties, mutual satisfaction of needs, and shared territory or place. Although it may be defined by either natural geographic or political boundaries, the key factor is that the people involved have a common interest in protecting an identifiable, shared environment and quality of life.

Since many individual community members or stakeholders join community-based groups related to environmental protection actions, this paper often uses the term of "community groups" as the target users of PPGIS. However, the term will be used interchangeably with community-based groups, community members, neighborhood groups, or local people.

The paper focuses on the issues related to PPGIS, rather than GIS technology itself. The paper excludes discussion of such issues as data transfer, standardization, user-friendly GIS, and technical problems, which are often dealt with in conventional GIS debates. In addition, the case studies may have some limitations for analysis because they are mainly based on their presentation in the literature.

Methodology

There are a variety of PPGIS approaches that improve public participation in the planning process and decision-making process, depending on the particular environmental, political, cultural, and societal situation. The paper uses four typical PPGIS approaches available in practice, and its case studies are as follows.

- Community-based PPGIS approach
- University/community partnership approach
- Web-based PPGIS approach
- Neighborhood GIS center approach

Each case study was selected based on community-based environmental protection efforts, different environmental concerns, objectives of PPGIS, and countries, including developed and developing countries. The paper will analyze and identify advantages and disadvantages of four PPGIS case studies. For this analysis, the paper makes and uses frameworks in terms of databases and GIS systems issues, implementation of PPGIS, and community involvement in the process.

Organization

The paper consists of five chapters. After this chapter's introduction of the paper, the second chapter contains two sections. The first section introduces the Community-Based Environmental Protection (CBEP) approach, why community groups use geographic information, the importance of public participation in the planning process, and the role of GIS in the planning process. The second section deals with the origin and concept of PPGIS, characteristics of PPGIS, including relationship with conventional GIS applications, and introduces the four PPGIS approaches and frameworks for analysis. The third chapter introduces four case studies as examples of different approaches: a community-based PPGIS approach (Southern Ghana case); a university/community partnership PPGIS approach (University of Illinois at Chicago/Pilsen community case); a Web-based PPGIS approach (United Kingdom case); and a Neighborhood GIS center approach (HRIC center, Australia case). After investigating each case example using analysis framework, the paper concludes with lessons learned from the case studies and draws implications of applying PPGIS in the planning and decision-making process.

Chapter 2. PPGIS in Community-Based Environmental Protection (CBEP)

2.1. Planning and GIS

2.1.1. CBEP approaches

Why are community-based and community-driven approaches important? In the last quarter-century the U.S. has achieved remarkable improvements in environmental quality (U.S. EPA, 1999). The success and progress of environmental quality has been achieved through appropriate regulatory and enforcement policies, primarily focusing on point-source pollution. However, today's environmental problems differ from those of earlier decades as social, political, economic, and human activities change. The problems are local and unique to a region or area, and the impacts of problems are beyond the single environmental medium—air, water, and land, requiring a holistic and collaborative approach to the environmental protection. The traditional, command-and-control approaches cannot effectively address many emerging causes of environmental pollution and ecological degradation. In response, EPA emphasizes the Community-Based Environmental Protection (CBEP) approach. EPA (1999) defines it as "a holistic and collaborative approach to environmental protection that brings together public and private stakeholders within a place or community to identify environmental and public health concerns, set priorities, and forge comprehensive solutions." Recognizing unique community characteristics, CBEP addresses problems where they arise and where the interest to solve them often lies in communities.

Moreover, local people have a substantial body of knowledge that might be useful for environmental planning and management. They may know where the pollution sources are, know how much forest uses are needed for their livelihood, identify priorities, or have a unique perception of natural resources. Outsiders might provide scientific and technical skills and economic support, but ideally, environmental problems within a community can be efficiently solved when stakeholders collect knowledge and actively participate in the planning and decision-making process. If environmental planning process involves an inventory of local knowledge, it will motivate them to participate and lead to stewardship activities.

2.1.2. Why public participation?

The greater the participation of residents in the making of a plan, the more likely it is that the plan will accurately reflect their needs and concerns. The greater the participation, the greater is the sense of ownership that people have about the plan, which can translate into a greater determination on their part to see that the plan gets implemented. And, the greater the participation, the harder it is for others, such as public officials, to ignore the plan (Jones, 1990).

In the traditional agency-driven approach to environmental planning, the community was given limited information and little chance for participation in the consequent plan. In the traditional planning process, the public was informed by public notice, and usually participated through public hearings. However, government agencies and technical experts still had power to make a decision while the public was limited in its involvement in problem identification or the development of alternative solutions. Over the last two decades significant changes have occurred. The federal and state governments devolved the power to the hands of local communities, and people have become more informed about a variety of issues through media and advanced information technology. These changes and empowerment of community led community-based groups to widen public participation in the planning process and to affect decision policies about their community issues.

Level of public participation

Public participation in the planning and decision making process includes several benefits: enhancing the capacity of citizens to cultivate a stronger sense of commitment, increasing user satisfaction, creating realistic expectations of outcomes, increased public trust, and community building (Al-Kodmany 1999). Arnstein (1969) first proposed the rungs of ladder for public participation with eight levels; from the base which represents zero opportunity to participate to the higher rungs representing increased levels of participation. From this model, Kingston (1998) modified it to a six-step ladder (Figure 2.1), which is more adequate for this paper.

- *Public right to know*: the public has only the possibility of awareness that some planning issue could be of interest
- *Informing the public*: the local authority implements some action plan in order to inform the people, but the people have no possibility to react
- *Public right to object*: the residents may say yes or no to a project, but have no possibility to react or to amend it
- *Public participation in defining interests, actors and determining agenda*: this is the first level of participation
- *Public participation in assessing consequences and recommending solutions*: the public is truly involved in analyzing the impacts of possible decisions and can recommend solutions which can be accepted to be implemented
- *Public participation in final decision*: this is real participation in the final decision; the decision is not only made by elected officers, but each citizen can vote whether or not to accept the plan

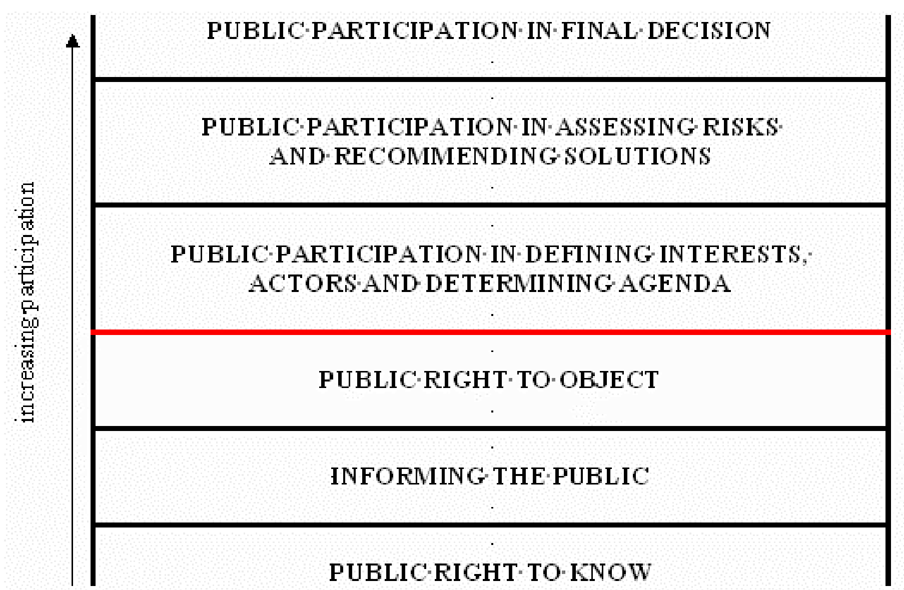

Figure 2.1 The public participation ladder (Kingston, 1998)

The planners and decision-makers use a variety of methods for facilitating public participation in the planning and decision-making process from the involvement techniques based on meetings (e.g., public hearings, public workshops, informal small group meetings, and advisory groups, etc.) to the techniques not based on meetings (e.g., providing information through mail or mass media, public opinion polls, surveys, and two-way communications such as "chat rooms" on the Internet). The PPGIS applications for improving public participation have unique characteristics in which they, with GIS technology, facilitate the public's participation in the data collection process, planning and decision-making process. How much the PPGIS applications improve the level of public participation depicted above depends on each PPGIS approach and method. For instance, the case study of community-based PPGIS of Southern Ghana, which will be discussed later, reaches the level of "public participation in defining interests, actors and determining agenda," whereas in the Virtual Slaithwaite case using Web-based PPGIS approach, the community members participate in the local environmental decision-making for their future community environment. Although some web-based systems try to provide geographic information to the public, many of them merely provide sample data in a one-way interaction, which are of little interest to the public. These systems would be located in the bottom two rungs of the public participation ladders. On the other hand, the Virtual Slaithwaite system promotes public participation level by providing spatial query functions and feedback to the users, and by allowing the public to input their comments about local issues in two-way communications, which in turn are reflected in local decision-making. The paper will discuss the each level of public participation in the case studies and how the PPGIS applications promote community involvement in the planning and decision-making process.

Effective public participation requires relevant and comprehensive geographic data and information for environmental planning and decision-making. The next section discusses the role of geographic information and GIS technology in the planning process.

2.1.3. The role of GIS in the planning process

It is possible for planners to use different approaches of the planning process, depending on the specific goals and objectives of the projects. For identifying the role of

GIS in the planning process, it uses the rational model, which is used by most planners (Anderson, 1995). The typical rational model of the planning process is given below. Although some phases of the planning process can be undertaken concurrently, others should be done consecutively (Anderson, 1995).

1. Identify issues, problems, goals, and objectives
2. Collect and analyze data and information
3. Develop and evaluate of alternatives
4. Make decisions
5. Implement the plan
6. Monitor and evaluate the plan

What is the role of GIS in this planning? GIS is well known as a computerized database management system that is capable of the capture, storage, retrieval, analysis, and display of spatial data. Planners can apply GIS in all aspects of the planning process, including data collection and storage, data analysis and presentation, planning and policy-making, and communication with the public and decision makers. GIS contributes to the development of a geographic database for planning-related analysis of the process. Considering the significance of data quality, data collection takes up a considerable proportion in the process (Nedovic-Budic, 2000). GIS has a powerful analytical tool that allows the user to identify the spatial relationships between map features and to display and forecast impacts of development through 'what if' scenarios. Finally, the visualization ability of GIS is very useful to planning. It can help planners to explore data and visualize the results of planning models by clearly displaying complicated public issues or problems. It can also enhance human-computer interaction in the decision-making process. Effective visual tools generate meaningful public input, help build trust, increase design awareness, and thus enhance communication during the planning process. A PPGIS case study through the partnership of UIC and the Pilsen community will show how the visualization function of GIS enhances public participation in the planning process.

2.2. Public Participation GIS (PPGIS)

2.2.1. Conceptual origins

Failure of traditional environmental GIS

With its unique analytical abilities and spatial representation of environmental information, GIS has long been recognized as an important decision support tool and has largely been viewed as a critical success both by GIS practitioners and their scientific peers (Cinderby, 1999). However, the methodology of traditional GIS has often been criticized as being a 'top-down,' and 'expert system' developed by technocrats (Cinderby, 1999, Harris and Weiner, 1998, Abbot et al., 1998, and Carver, 2001). Outside technical experts set the goals and the information relevant to realizing them. Social and cultural information has largely been excluded from environmental investigations, although this deficiency has been blamed on society's priorities rather than inherent limits in the technology itself (Cinderby, 1999 and Weiner et al., 2001). The high costs and high levels of training for GIS analysis have made the systems available only to governments or wealthy institutions, limiting information access to select groups. In its traditional mode, GIS actually works against participation and empowerment (Carver, 2001). Because of the institutional location of the GIS production process, the technology tends to become further bureaucratized (Harris and Weiner, 1998)

PPGIS concept was created to overcome these criticisms by enhancing public participation and considering communities that will be involved with, and affected by, development projects and programs. Unlike traditional GIS applications that are implemented by GIS professionals, users of the technology in PPGIS are members of the community who are often assisted by a facilitator with expertise in GIS (Kyem, 2000). While the conventional GIS applications often focus on the outcome, PPGIS projects emphasize the processes by which the outcome is attained (Obermeyer, 1998). Therefore, the result of a PPGIS project is often that of participant empowerment.

Conceptual origins

While community planning has been a topic of debate in planning for several decades, PPGIS is a relatively recent phenomenon (Young, 2001). The phrase "public participation GIS" comes to the GIS community from the planning profession (Obermeyer, 1998). The term was coined by the organizers of a mid-1990s workshop, who wanted to connect planning and GI Science.

The first workshop to discuss the topic of PPGIS was held in 1993, sponsored by the National Center for Geographic Information and Analysis (NCGIA). The US National Center for Geographic Information and Analysis (NCGIA) has run two related initiatives, Collaborative Spatial Decision Making (I-17) and The Social Implications of How People, Space & Environment are Represented in GIS (I-19), known simply as "GIS and Society" in 1996 (Carver, 2001). The latter focused on three broad conceptual issues: the epistemologies of GIS; GIS spatial data institutions and access to information; and developing alternative GIS (Weiner et al., 2001). Participants at the meeting questioned whether a 'bottom-up' GIS could be successfully developed, and discussed what forms this system might take. A number of other probing questions were raised, including how community participation could be incorporated into a GIS, and to what extent such participation would serve only to legitimize conventional top-down decision-making. The recent Varenius initiative on "*Empowerment, Marginalisation and Public Participation GIS*" identifies a broad range of issues relevant to community representations and PPGIS (Varenius, 1998). These include:

- 'Successful' implementations of a public participatory GIS
- Changes in local politics and power relationships resulting from the use of GIS in spatial decision-making
- What community groups need in the way of information and the role GIS plays or could play in meeting this need
- Current attempts to use GIS to 'empower' communities for spatial decision-making
- GIS changes in local politics and power relationships resulting from the use of GIS in spatial decision making

2.2.2. Characteristics of PPGIS

While the overall characteristics of PPGIS are becoming clear, defining specific components of PPGIS is no easy task (Weiner and Harris, 1999). As a result, a variety of approaches to PPGIS implementation are emerging. In general, the PPGIS can be characterized below. The case studies presented in the next chapter show all, or part of, these characteristics.

- Public participation, empowerment, and bottom-up approach
- Incorporation of local knowledge
- Provisions for widening public access to GIS information
- Addressing social and political relationships
- Integration of innovative techniques such as diverse visualization tools, multimedia, and the Internet

Although the PPGIS approaches vary greatly from situation to situation, all PPGIS applications address concerns of community participants. The concept of PPGIS captures GIS technology as a useful tool for facilitating the participation and empowerment of community groups by providing them with increased, appropriate information for decision-making. The actual nature of the public participation process itself in implementing PPGIS is critical because it may alter the specific PPGIS design, content, structure, and implementation (Weiner and Harris, 1999). In some cases of PPGIS, Obermeyer (1998) argues that the technical performance of the GIS, spatial accuracy, and quality of output may be secondary to the need for a participatory approach.

PPGIS enables the community groups to develop a PPGIS by collecting and inputting data in a bottom-up approach, using GIS technology, tailoring spatial information according to their needs, and participating in the planning and decision-making process. The community-based PPGIS application of Southern Ghana case study, which will be presented in the next chapter, is a good example of the public participatory work involved in obtaining resource information and the feedback meetings. These participatory activities gave community members a sense of ownership and involvement in the process, raising consensus building. Jordan (1998) argues that these social processes are very important, and should not be ignored by concentrating solely on the technical performance of the PPGIS.

PPGIS assumes that local knowledge is valuable (Weiner and Harris, 1999). Local people usually know their local area and problems better than anyone else. They can provide detailed insights of local phenomena. In this regard, the community itself needs to be regarded as a form of database. Although traditional spatial data are available across communities at a variety of scales and resolutions, they lack local knowledge and community perspectives. One of the strengths of PPGIS is to incorporate local community level perspectives. When local people can incorporate their local knowledge into GIS through participating in data collection, they are likely to feel ownership of information and systems. It can result in more active participation in the planning process. The combination of existing environmental information with that obtained from the local people allows greater insights into the limitations of and possibilities for a particular environmental problem. It may lead to different solutions that might otherwise have been reached using purely traditional forms of data (Carver, 2001). Moreover, opening restricted information to public access and expanding public input in decision-making process make decision-makers themselves become more accountable for their actions.

The traditional GIS has been accused of not fully addressing and incorporating social issues (Cinderby, 1999). The concept of PPGIS emerged in the context of GIS and society discussion and debate. The discussion about GIS production, use, access, and representation is based on an understanding of the social impacts of existing applications of geographic information systems. Weiner and Harris (1999) argue that these origins are important because PPGIS and its current directions cannot be conceptually, empirically or politically disconnected from core GIS and society issues. PPGIS is neither objective nor value free. Its objective is to include community members, so that it is dependent upon human choices and constraints regarding the selection of coverages and attributes, scale, analytical procedure, and the decisions and outcomes arising from these analyses (Weiner et al., 2001).

2.2.3. Four different approaches to PPGIS applications

What approaches or methods are possible for community groups applying PPGIS to community-based environmental protection? This section introduces four different

PPGIS approaches suggested by Leitner et al. (1998)[1]. The next chapter explores case studies of each PPGIS application in the environmental planning.

The four PPGIS approaches differ from one another along one or more of five dimensions (Leitner et al., 1998). The five dimensions are the communication structures connecting communities with GIS facilities, the nature of the interaction with the GIS, the physical (geographical) accessibility of the GIS to the community organization, the stakeholders involved in making the technology available, and legal and ethical ramifications. Table 2.1 shows these dimensions and their attributes.

Dimensions	**Attributes**
Communication Structures	Independent Nodes Radial Connectivity Network Connectivity
Nature of Interaction with GIS	No Direct Use Passive Use Active Use Proactive Use
Location	In-house GIS Virtual (Web-based GIS) Remote GIS (outside the community)
Stakeholders	Local and Non-local State Agencies Nongovernmental organizations (NGOs) Educational Institutions Private Sector Institutions Within community stakeholders
Legal and Ethical Issues	Ownership of/ responsibility for spatial databases Access to publicly held information Issues of privacy

Table 2.1 Dimensions and attributes of PPGIS approach (Leitner et al., 1998)

Communication structures

- Independent nodes: each community organization operates its own GIS in relative isolation from one another
- A radial structure: community organizations' use of GIS centers on separate use of a common facility

[1] Leitner et al. identified six different approaches for making GIS available to community groups in their paper. The approaches excluded in this paper are "GIS facilities in universities and public libraries" approach and "Map rooms" approach.

- A network structure: community organizations communicate directly with one another as they use GIS

Nature of interaction with the GIS

- No direct use: no direct use at all
- Passive use: individuals' use is dictated by the maps and databases available, and by standardized GIS procedures
- Active use: the user is free to develop their own operations and classifications of given databases
- Proactive use: users can input their own data and benefit from a variety of information technologies best suited to those data

Geographical location

- In-house GIS: local access in the community
- Virtual: virtual access over the information networks (e.g., Web-based GIS)
- Remote GIS: physical travel to a location outside the community is necessary to use GIS

Stakeholders:

Stakeholders refer to internal and external individuals and institutions, whose degree of involvement can affect the responsiveness of the GIS to community organization needs.

Legal and ethical issues:

The PPGIS approaches differ in terms of who has legal ownership of databases, whether the communities have access to publicly held information, and the privacy issues.

The following discussion explores the differences of the four PPGIS approaches based on the dimensions. Table 2.2 summarizes the characteristics of each approach associated with the dimensions and attributes at the end of this section.

Community-based (in-house) GIS approach

The establishment of in-house GIS technology and databases by community organizations for community-based environmental planning is a rare and rather recent phenomenon (Leitner et al., 1998). In some cases, community organizations develop and independently create databases and GIS technology. However, it is not easy due to

Dimension / Attributes	PPGIS Approaches			
	Community-based GIS	**University/ Community**	**Internet Map Serves**	**Neighbor-hood GIS Centers**
Communication				
Independent nodes	O			
Radial connectivity		O		
Network connectivity			O	O
Interaction with GIS				
No Direct Use		O		
Passive Use			O	
Active Use	O		O	
Proactive Use	O			O
Location				
In-house GIS	O			
Virtual			O	
Remote		O		O
Stakeholders				
Local/non-local state agencies			O	Depends on the type of the center
NGOs	O			
Educational institutions		O		
Private sector				
Community stakeholders	O			
Legal/Ethical Issue				
Ownership/responsibility	O			
Access to information				
Privacy/surveillance			O	O
Checks/balances				O

Table 2.2 Characteristic of four PPGIS approaches based on dimension/attributes (drawn from Leitner et al., 1998)

enormous costs and personnel with skills required. In other cases, as the study case of Southern Ghana, the PPGIS project is facilitated by government agencies to help community groups to establish an in-house GIS and GIS databases.

A community-based GIS is usually designed as an independent node located within the community organization, usually at its office. It makes it possible to gain direct and immediate access to information as needed for their purposes. The unique characteristic of the fact that community groups are the primary stakeholders in an in-house system allows community groups or users to tailor to their needs, so that they can create and interactively manipulate their own databases and maps.

While community organizations do not assume primary legal responsibility, they may face legal issues regarding community-generated databases such as privacy issues and a question on what constitutes legitimate information to include in a GIS database among different stakeholders in the community.

As a case study of this approach, the next chapter will discuss how PPGIS was implemented for community forest management in Southern Ghana.

University/ Community Partnerships approach

Increasingly, universities within some communities are attempting to assist their local community groups with their mapping needs. One common approach is to provide assistance through course projects, as in the second case study of this paper. Based on partnerships, faculty, students, and community members work together to identify goals, sources of spatial data, and specific mapping needs. The final result of this approach would be a group class presentation and delivery of a series of maps.

According to Leitner et al. (1998), this approach includes three different types: basic community service, service learning and action research. In basic community service, volunteers, for example an on-going student volunteer, work with a curricular link, producing a set of map products desired by the community. In service learning, faculty and students provide the community a GIS application based on a community request, and then reflect on the lessons learned from the experience. Action research differs from the previous two types in that it emphases a fully collaborative, inclusive, and full participation of community members in the process of defining, examining and deriving solutions to problem. By emphasizing community participation in various stages of a project, the community members may have potential empowerment affecting the change of public policy.

The communication structure of this approach represents radial connectivity in that the university provides information and data to the community groups. Because of this strong reliance on university expertise, community groups rarely maintain their own systems and have no direct use of the technology. Finally, since the university provides data for community organizations, there are no significant concerns with ownership and accuracy of databases.

In the next chapter, the paper will explore, as a case study of this approach, the experience of the University of Illinois at Chicago and the Pilsen community designing their future with GIS technology and visualization tools.

Internet Map Serves approach

Internet Map Serves is provided over the Internet by institutions establishing a Web site. It includes city government, universities, private companies, or non-governmental organizations. In addition to supplying simple cartographic displays, one website, the Virtual Slaithwaite using web-based GIS which will be discussed in the next chapter as a case study, provides spatial queries or perform analyses.

The network connectivity of communication structure allows the users ubiquitous access to spatial information in terms of space and time. Interaction with the server can vary from passive use, where spatial information is served in a typical server-client approach, to a more active model where users can query and manipulate data remotely. This approach represents a virtual interaction with the system because GIS software and hardware is not needed on site. However, if the server simply maintains and provides already designed and manipulated maps, it is not a true GIS. The data provider has ownership of data.

Neighborhood GIS Centers approach

A neighborhood GIS center approach can be developed by neighborhoods pooling their expertise and resources. In the case study of Herbert Resource Information Center (HRIC) in Australia, which will be discussed in the next chapter, several stakeholders, representing local industry and community and government agencies, developed it through collaborative approaches. The funding for a center can come from the community groups themselves or other organizations, such as a non-profit foundation, a private sector or the state. After setting goals and principles, a center provides users with the capacity to gain access to databases or to input information gathered by the communities themselves. A center represents a network communication structure by collaborative actions of communities in the development and use of the center and the sharing of knowledge and expertise. It has the capacity for proactive use in the sense that communities can bring their own information into the GIS, creating the capacity for innovative integration of other kinds of information with GIS. A variety of different approaches of center can exist depending on the funding sources, who are stakeholders, and the collaborative efforts among community organizations.

The legal and ethical dimensions also depend on the details of its development. Active and successful collaboration can make it easier to develop mechanisms of checks and balances which are sensitive to community issues (i.e., based within the community organizations rather than subjecting them to the control of external stakeholders), avoiding self-interested regulation by community groups of their own activities. However, a center can also encourage abuse. Because of expertise and data shared, information from one organization may be inappropriately made available to other organizations.

2.2.4. Frameworks for case study analysis

This section discusses the framework used to analyze each PPGIS approach. The paper uses three dimensions to examine technical issues, implementation issues for a successful application, and public participation in the process. The dimensions are (1) database and GIS systems, (2) implementation of PPGIS, and (3) community involvement. The database and GIS systems dimension includes improved accessibility, quick and flexible availability to community needs, ability to manipulate data, data and products quality, and compatibility with other types of tools. As a measurement of efficiency of implementing PPGIS, the implementation dimension uses such factors as simplicity of implementation, costs to the community, compatibility with cultural and social structure of community, service for education and training, and operating and maintenance. Finally, community involvement in the process dimension is added to reflect the attention to public participation issues in the planning and decision-making process. The descriptions of each factor will be presented in this section.

This framework classifying three dimensions has some limitations. First, these dimensions will not be used to evaluate each case study but to compare the relative differences between the case studies. Evaluation of each case study is beyond the purpose of this paper. Second, the dimensions used in this paper do not encompass some important factors. For example, user-friendly GIS system and users satisfaction are crucial factors for evaluating successful PPGIS because they could be basic indicators for enhancing public participation. Nevertheless, due to the limitation of this, this paper does not include those factors for the analysis.

Database and GIS systems issues

- *Community's ownership:* Who has legal ownership of database is an important issue. When community groups own their databases and GIS systems, they are responsible for managing the database and are likely to actively participate in the analysis and planning process.
- *Improved accessibility:* Access to data is one of significant issues in PPGIS. Increased participation by community groups in planning and decisions that affect their community is based in part on the availability of and access to information.
- *Ability to manipulate data:* Ability to manipulate data and information is associated with the ownership of database and GIS systems. If the community groups own them, they will be able to tailor their own data and information needed for planning, monitoring, and organizing.
- *Quick and flexible availability to community needs:* The timeliness, flexibility, and responsiveness of information are other issues. For community groups requiring appropriate information, information and data should be available immediately and flexibly responsive to community groups' needs and issues.
- *Level of active use:* Can community groups actively use data and GIS systems? This level is associated with ownership of the database and GIS system, accessibility, and flexible availability of the database to community needs.
- *Data and product quality:* Data and product quality refer to accuracy, relevance, usefulness, and reliability. The contents and databases integrated by various types of database should be accurate and current, and the outputs using collected data should not introduce errors.

- *Compatibility with other types of tools:* This factor does not appear to be a relevant issue in data and GIS systems. However, if GIS systems can be used compatibly with other visualization tools or communication tools, including the Internet, they can help community members better understand and encourage public participation in the planning and decision-making process.

Implementation of PPGIS

- *Efficiency (Simplicity and speed):* Efficiency refers to the simplicity and speed in implementing PPGIS. Coordinating GIS data and analysis tasks are sometimes are complex and even tedious.
- *Level of community's capacity to use GIS independent of experts:* Can community groups utilize data, understand the GIS process and interpret the final maps without the aid of external experts? This community capacity is the basis for the bottom-up approach in using GIS.
- *Community's cost-effectiveness:* The community groups need budgets to purchase and get digital spatial data and GIS systems, including hardware and software, as well as to maintain them for adopting GIS technology. Funding sources are one of the significant barriers for the community groups applying GIS to environmental planning and analysis.
- *Compatibility with cultural and social structure:* The concept of PPGIS assumes that local knowledge is valuable. The GIS technology should be compatible with the culture, practices, understandings, issues, and social structures of the community.
- *Service for education and training:* In spite of the recent development of easy-to-use GIS, complex techniques can be difficult for laymen to understand, requiring a relatively lengthy learning curve. If community groups are not able to understand how to use it, the PPGIS may have little effect. In addition, as personnel changes, educational programs are needed to sustain trained users of GIS and databases.
- *Sustainability of operating and maintenance:* The database and GIS systems should be sustainable if they are operated and maintained by the community

groups. Given that community groups usually are resource poor in terms of financial and human capital, long-term maintenance issue is important.

Community involvement in the process

At each phase of GIS development and the planning process, a variety of factors may improve public participation. One example is a joint activity of data collections by community groups. This paper will examine in which phases and what ways each PPGIS approach is applicable. Finally, the level of public participation ladder each case study reaches through improving public participation will be presented, based on the six public participation ladders suggested by Kingston (1998).

- Data collection
- Identify problems/issues
- Analysis
- Decision-making/problem-solving

Chapter 3. Case Studies

3.1. Community-based GIS: local forest management, Southern Ghana

Background

In parts of Sub-Saharan Africa, anti-conservation activities of local communities have severely impacted forests (Kyem, 2000). After reviewing a forest policy regulating the use of forest resources, the State government realized the importance of an alternative to official rule, requiring inter-group mediation between public officials and local communities. With some financial assistance from other agencies, the Forest Department, which was charged with the implementation of the project, developed the Collaborative Forest Management Project (CFMP) to organize foresters and local community representatives into village-based forest committees for the management and protection of forest reserves in the country (Kyem, 2000). In addition, the Forest Department had acquired several GIS facilities. The large-scale of GIS and remote sensing facilities and the need of collaborative forest management made a new method, a Public Participatory GIS, termed ESCMAP (Exploratory Strategy for Collaboration, Management, Allocation, and Planning). The objective of the project was to integrate the concerns, experiences, and customs of local groups into official forest management practice, involving the creation of a database of information on selected Forest Reserves. The project was implemented in four forest-dwelling communities. This case study examines the PPGIS project for the Aboma Forest Reserve, which was used to facilitate planning for the protection of a local forest reserve in one of the four communities, Kofias.

Case area

Kofiase had about 1,200 inhabitants in 1995. The town is located 40 miles northeast of Kumasi, the capital of the Ashanti Region, and 250 miles from Accra, the capital of Ghana. The Aboma Forest Reserve is located on an undulating land ranging in altitude between 800 feet in the northern and central portions to about 1,800 feet over rugged terrain at the southwestern portion of the reserve.

Environmental concerns and problems

The Aboma Forest Reserve is located on the fringe of the dry savanna grassland vegetation. This made the reserve subject to annual forest fires during the dry season, destroying the original forest vegetation and converting it into teak plantations. Facing the shortage of available fertile land to make new farms, the inhabitants of the community frequently break laws regulating the use of local forest resources. Consequently, it generated conflicts between local people and forest officers charged with the management of forest reserves.

Committee

Prior to the implementation of the PPGIS project at Kofiase, a Collaborative Forest Management Committee (CFMC) was formed in the town (Kyem, 2000). The forest committee comprised twenty-one members (fifteen were natives of Kofiase and six were foresters from the local office of the Forest Department of the country). The local community representatives included retired and active teachers, civil servants, farmers, traders, and citizens representing various interest groups in the community. Many of the representatives were literate and also knowledgeable about issues relating to the development of the local forest reserve.

PPGIS mapping process

The process of the community-based PPGIS for the Kofiase forest management is shown in the Figure 3.1 The GIS was used to facilitate group discussions through this process. At the beginning of the project, several workshops took place to introduce participants to mapping, the interpretation of maps, and the overlay capabilities of the raster GIS. The hard copies of the maps facilitated participant discussion about the impacts of deforestation, relationships between hills and streams, and sources of water supplies to villages within the community. Such preliminary exercises emphasized the need to preserve the forest to ensure the future supply of basic resources (e.g., freshwater from streams) used by the community.

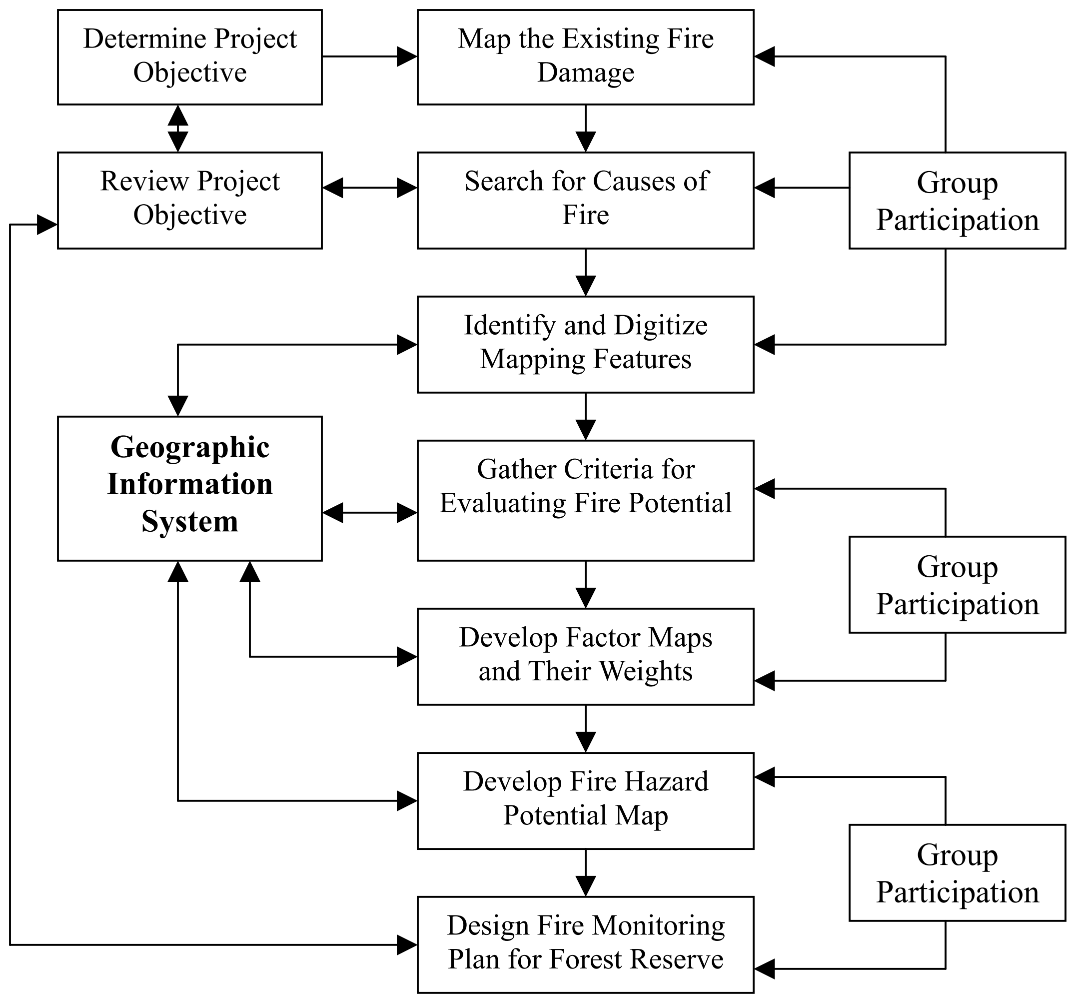

Figure 3.1 A flow chart of the PPGIS process (Kyem, 2000)

To prepare a fire hazard potential map, the members of the forest committee visited the forest to assess and map past and current fire damages. With the aid of experts, they digitized and stored databases into the GIS. After a series of discussions, members identified conditions, called factors that promoted the ignition of fire within and outside the reserve. These factors were later used for evaluating the fire hazard potential of the forest. After developing the factor maps, the participants created weights that reflected the significance of each factor in evaluating the fire hazard potential map. These raking and weighting processes significantly improved the relationships between local foresters and the representatives of the committee though lively discussions. They probed each other's rankings until they collectively agreed on a common rank for each pair of factors.

For the comparison, the factors' weighting were standardized. Using GIS a final map was developed by reclassifying into four main categories: (1) very low risk, (2) low risk, (3) moderate risk, and (4) high risk. The committee finally adopted the final fire hazard potential map, which included the design of a fire-monitoring plan to protect the forest. They allocated the personnel and equipment to the areas that recorded very high fire hazard potentials. Areas of low fire hazard potential were targeted for periodic visits. Furthermore, using the maps the forest committee agreed to launch an environmental education program at Kofiase and the surrounding villages to explain the impact of fire on forest resources.

Concluding comments: advantages/disadvantages

In most cases, the community-based GIS approach uses and receives assistance from third parties such as universities or diverse agencies for technical assistance and funding for a project or program. It is an ideal approach for collaborative participation and decision-making in terms that the community is empowered to do GIS analysis by themselves. Community groups gain direct and immediate access to information as needed for their purposes. They check the data, run queries, and create and interactively manipulate their own databases and maps. In the Southern Ghana case study, many participants stated that joint data gathering and processing sessions helped them develop a common sense of mission for the protection of the local forest reserve (Kyem, 2000). It also helped them know more about their opponents and develop trust for each other, harmonizing multiple viewpoints. The adoption of the community-based PPGIS approach resulted in an improved democratic decision-making process (Kyem, 2000). It was possible by virtue of group discussions at every mapping and planning stage. Another benefit of the approach is that community members are the primary stakeholders in developing PPGIS. It allows quick and flexible response to community issues, and has the potential for broader development impacts because community members own and use the databases and GIS technology even after finishing the project.

In spite of its independent characteristic, this approach has numerous drawbacks. First, the community must be able to trust GIS specialists who assist them. From the experience of Ghana, when the experts met indigenous people, they were skeptical of innovation and particularly suspicious of public officials and experts who came into their community with an agenda (Kyem, 1998). Second, the community must have a very serious commitment to continue using this technology. Especially when the specialists leave the community, the community may face the challenge of maintaining the GIS databases and systems. In spite of increasingly user-friendly systems, the GIS technology still requires a significant amount of training. In addition, rapid turn-over of staff and participants, unstable funding sources, and lack of expertise seem to impede the implementation and long-term maintenance of GIS. Finally, the Southern Ghana case study shows cultural and institutional obstacles to successful PPGIS practice. Culturally, the community depended on traditional customary practices—a relatively independent and self-sufficient system. Institutionally, the Forest Department lacked an effective administrative mechanism for managing land-based resources.

3.2. University/Community Partnership: University of Illinois at Chicago and Pilsen Community

This case shows the partnership PPGIS approach of the University of Illinois at Chicago (UIC) and the Pilsen community, using GIS as a visualization tool for promoting public participation in Chicago's Pilsen neighborhood planning process. During different phases of the planning and design phases, three different visualization tools were used: GIS, an artist, and computer photo-manipulation. Each of theses tools was highly effective in promoting resident participation in the planning and design process (Al-Kodmany, 1999)[2].

Background of Pilsen community and their concerns

Pilsen is a largely Mexican-American and Mexican immigrant community of nearly 50, 000 people, located immediately adjacent to the UIC. Community leaders were concerned about urban blight and decay, vacancies, and crime, and wanted to preserve the cultural heritage in the physical form. They were particularly interested in promoting commercial tourism along the 18th Street, the neighborhood's main commercial district.

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[2] Examples of images illustrating three visualization tools used during the design workshops are available on the World Wide Web at http://www.evl.uic.edu/sopark/new/RA/#sub1

University/ community partnership: creating a planning team

For taking serious actions and improving the neighborhood environment, the community leaders realized that both the meaningful involvement of all stakeholders and the technical experts at the University of Illinois were required to strengthen the sense of community, and thus a participatory, cooperative approach would help achieve their purposes. In response to the request of Street Development Corporation's (ESDC) leaders, planners and designers of UIC joined with residents in 1998 to implement a participatory planning process. A planning team was formed that included 25 community residents (including representatives of the 18th Street Development Commission), and two architects, two planners, and one artist from the University.

Visualization tools for enhancing community participation: GIS, artist and computer photo-manipulation

After the first working session presenting dozens of slide images to the community members, University design professionals realized that the presentation and visualization techniques using slide images did not lead to active involvement among the residents because of their fixed sequence. The technical experts needed to develop an interactive visual 'language' that would enable all members of the planning team to fully participate in the process. First, University planners developed an interactive GIS image database. It contained maps, attribute data of demographic information, physical conditions, and socio-economic data, as well as images, showing the current neighborhood characteristics, the existing conditions of the 18th Street Corridor and a few historic images. In addition, since GIS technology did not have the capacity to transform human ideas into conceptual designs, the team used a UIC artist. The artist was needed to reconstruct the scene according to the participants' wishes and concerns, capturing the participants' multiple perceptions. To do this, she used an electronic sketchboard, an easily erasable drawing board, or white board. The artist was helpful in drawing larger sketches of particular items or showing more detail.

At the first phase of the design process, these two tools were used. While the GIS showed images of the existing condition ('before' scenario) of different areas of the community, the artist's sketches showed potential design solutions ('after' scenario). The artist immediately incorporated participants' comments into the sketches. The interactive maps and images enabled participants to immediately understand and visualize community data. Together, two tools helped the residents feel the real and allowed participants to build consensus and to draw out local knowledge. Rather than simply reviewing a final plan, residents truly became co-planners and co-designers by being involved in the development of the design plans.

After a series of workshops using first two tools, the advanced workshops were held to assist residents in evaluating design changes. The UIC team identified physical design elements that had been discussed in the previous workshops, collected and imported digital photographic images, modified the images, and finally added the images as layers to the original photographic images of neighborhood sites. These layers, which could be turned on or off, allowed participants to depict realistically what they wanted design elements to look like when placed into the physical neighborhood context. By turning on and off different layers, it enabled the planning team to visualize changes and make informed comments about the proposals, and participants to engage in a lively discussion about the individual designs.

Concluding comments: advantages/disadvantages

The partnership of a university and a community is the most prevailing approach. Because a university supplies the data, software, and analysis to the community, community members do not have to learn about GIS techniques and worry about technical problems. They can easily access the rich potential sources of GIS expertise. Moreover, costs and time necessary to purchase and maintain databases and GIS systems to community are lower. In the UIC/Pilsen community case, the combination of different visualization techniques promoted strong community involvement in the planning process. The workshops and visualization tools helped build a relationship of trust between the University and the community. During the process, the GIS and the artist were useful in the first two sessions, helping community residents understand the existing environment conditions and articulate their ides, whereas photo-manipualtion was the most appropriate tool in the advanced sessions designing the future of their community environment.

On the other hand, the strong reliance on university expertise resulted in several disadvantages. Community groups rarely maintain their own systems. It is hard for community members to directly participate in analysis because they do not have the opportunity to work with the GIS themselves to discover solutions by themselves. They are dependent on the outside experts. In addition, universities may have limited capacity to provide services (university's help may not be available when a community needs help) and lacks long-term commitment of maintenance and partnership. A university project agenda may not fit with that of community, and faculty/students may not fully understand the community's needs. The UIC/Pilsen community case revealed a few other drawbacks (Al-Kodmany, 1999). Using the GIS in the church required transporting large amounts of equipment to and from UIC. The computer was often slow in processing information such as loading images and overlaying thematic layers. These delays often prolonged the planning process and interrupted the constant flow of ideas. Performing the computer photo-manipulation required considerable preparation before the workshop took place. Finally, the costs of developing the GIS system to the University were substantial due to the labor-intensive activities required in gathering and assembling the images, maps and historical data.

3.3. Internet Map Serves: Web-based GIS of Virtual Slaithwaite, UK

This case study discusses Web-based GIS of Internet Map Serves approach as a means of enhancing public participation in local environment decision-making in the UK. In addition to traditional methods of public participation, Kingston et al. (2000) argue that new Internet-based technologies have the potential to widen public participation. This section examines the Village-based "Planning For Real (PFR)[3]" exercise of Slaithwaite, West Yorkshire in the UK, as a real environmental decision support system.

[3] PFR is an idea developed and patented by the Neighborhood Initiatives Foundation (NIF) in the UK, as a means of involving local people more closely in local environmental planning problems and decision-making (Kingston et al., 2000).

Environmental problems and Web-based PFR initiative

The critical problems of Slaithwaite village were disruptions caused by canal restoration, and the serious traffic problems caused by limited access options to local mills and industrial premises. There were also many issues surrounding public buildings, with many of the old buildings in disrepair, and the potential uses to which local green space may be put (Kingston et al., 2000).

Faced with conflict issues and views of residents, the people who initiated the meeting held a public meeting in Slaithwaite in 1997 to investigate what the villagers really wanted for the future. The participants agreed to create a community-led PFR initiative to take effective action and to fully involve the community members in a local planning decision. Colne Valley Trust (CVT), a local community action group, arranged a RFR exercise with assistance from the Neighborhood Initiatives Foundation (NIF), partly funded by the local council. This was called "Virtual Slaithwaite" and is still used on-line[4]. It was used as a focus for local discussion about planning issues within the village with a simple method of PPGIS by running a parallel exercise over the Web.

Web-based PFR in practice

The Virtual Slaithwaite system is an online PPGIS facility. A community database stores all user inputs through Web access logs. This process is an essential part of the system for validating user responses, for providing feedback into the planning process and for future analysis. Once the profile is complete and submitted, users can view maps, performing zoom and pan operations, ask such simple questions as "what is this building?" or "what is this road?" and then make suggestions. The Web browser window consists of four frames (Figure 3.2). It includes an initial screen of "Instructions and Help" information, and when a user selects any feature on the map, the small window in the top left hand corner of the screen displays what this is. The users can fill in and submit their comments though a "Choice Menu" or a free form text box.

[4] http://www.ccg.leeds.ac.uk/slaithwaite/

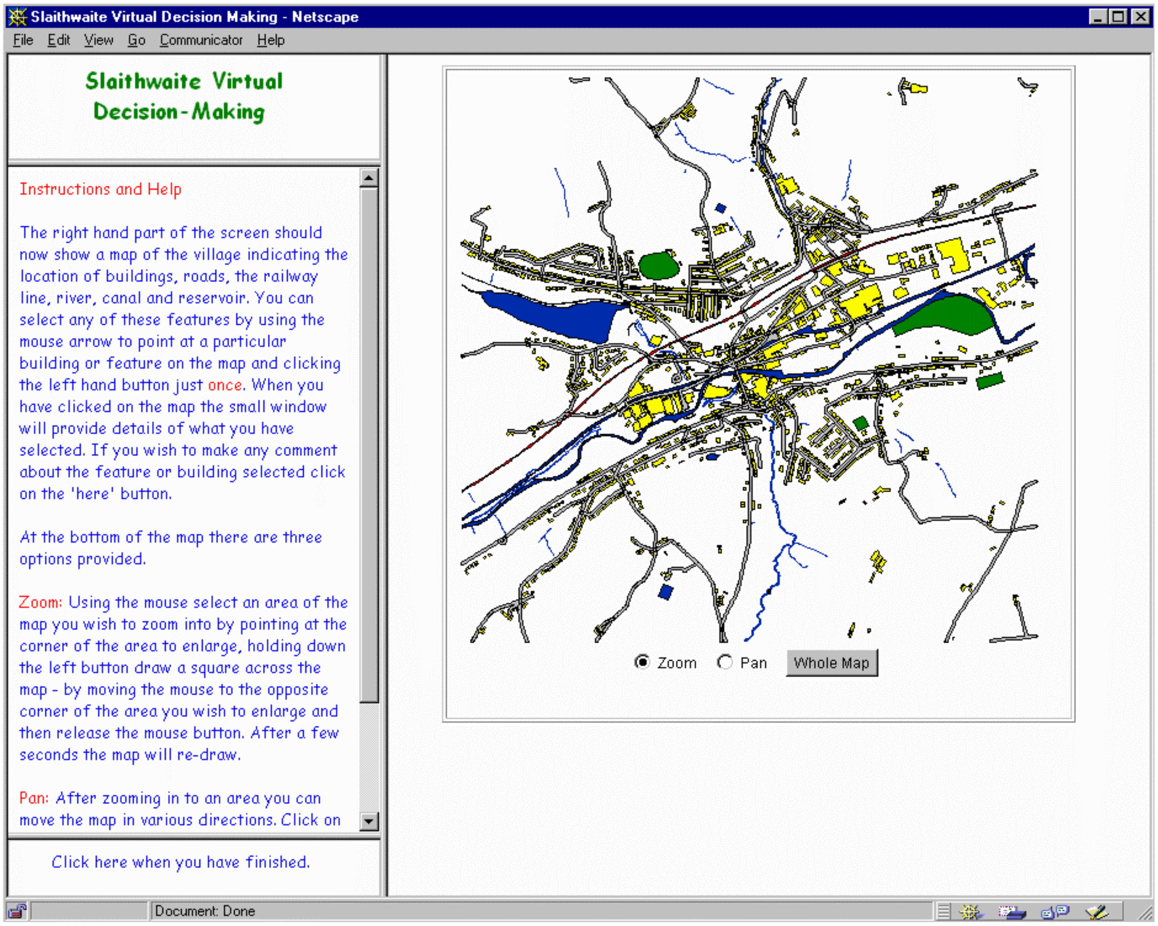

Figure 3.2 Virtual Slaithwaite (Kingston, 1998)

When the users exit the system, a series of questions ask them how they felt about using the system. In this manner a community database can be created, representing a range of views and opinions about planning issues within the community.

Concluding comments: advantages/disadvantages

As computers become more widespread, the use of web-based PPGIS is likely to increase. The fundamental benefit of the approach is to provide 24/7 access (24 hours a day/ 7 days a week) to the information at any time of the day and any location that has Web access, opening up opportunities for more people to participate in public consultations. The villagers of Slaithwaite could save time and money through directly entering comments into the Web. The Slaithwaite Virtual system also offers a high degree of flexibility in that the database can be continually altered or updated with public input and more relevant information throughout the public participation process. The direct access offers the potential for facilitating two-way interactions, though it depends on how the site is designed. In addition, users will become familiar with this type of participation as the use of animation and 'real-world' images incorporated into such a system increases.

However, accessibility can be limited depending on the computer capacity. Also the users do not have access to external expertise to interpret maps and data. Using the Internet creates a new problem, "digital divide," related to the access issue. Those who, the information underclass, do not have the appropriate training or intelligence with which to use it may be excluded from the decision-making process. If public access points, such as a community center of a public library, are needed, the suitable points should be considered at the first phase of the process. The actual ownership of different pieces of information and data is another significant concern. It can cause complex copyright and legal issues in relation to who controls and owns the information. The Virtual Slaithwaite system was possible because they have had the necessary skills and infrastructure for putting a Web-based PPGIS together (Kingston et al., 2000). Thus, for successfully implementing a Web-based PPGIS, personnel with the necessary responsibility and skills will be required in the first place.

3.4. Neighborhood GIS Center: Herbert Resource Information Center, Australia

The case of the Herbert Resource Information Center (HRIC) is the unique example of a community-based GIS center. This initiative was developed through a collaborative joint venture in the rural catchment of Australia. The most distinctive features of the HRIC are its capacity building function for stakeholders and the enthusiasm, and willingness to learn on the part of the participants (Walker, et al., 1998). Commitment to joint projects made it possible for the community members to feel a sense of ownership and involvement in the decision-making process.

Case area

The Herbert River catchment drains an area of approximately 10,000 km^2 in Australia's sub-humid to humid tropical north-east to the Coral Sea. Large areas of the catchment remain under natural vegetation (much managed for extensive cattle grazing), although approximately 35 to 40% of the coastal lowland area has been cleared for crop production or improved pastures. The catchment has a population of approximately 21,000.

Environmental concerns and problems

The Herbert catchment, where the sugar industry dominates the local economy, experienced strong economic growth underpinned by its tourist and agriculture sectors. The sugar industry had the potential for significant environmental impacts on the Herbert catchment. Clearing for sugarcane has significantly reduced the wetlands, swamps and billabongs. The stream banks in sugarcane growing regions removed considerable areas of the riparian vegetation. There were also concerns about water quality in both ground and surface waters. Growing competition between agriculture, forestry, conservation, tourist and recreational uses, urban encroachment, public utilities and hobby farms increased community interest in the preservation of the natural environment, community involvement in decision-making, and effective conflict resolution.

Establishment of the Herbert Resource Information Center

The government agencies in most Australian states implemented an Integrated Catchment Management (ICM) program to avoid the environmental and social damage sustained by conflicts in land use. In practice, the effectiveness of such initiatives was often constrained by a paucity of data at spatial and temporal scales relevant to decision-making, poor coordination or communication between participating stakeholders, limits to the data processing, and a poor understanding of key issues in sustainable resource use (Walker et al., 1998). For improving adequate data, a joint venture, the Herbert Mapping Project (HMP), was formed between 11 agencies (industry, community, and state, local and federal government) to fund the acquisition of digital orthophotography, cultural data (e.g., utilities, farm boundaries), natural features (e.g., streams, topography) and cadastral data for the lower catchment. As the HMP neared completion, many stakeholders realized that the data in digital form and GIS technology were required for advanced analysis. As a result, a further collaborative joint venture, the Herbert Resource Information Center (HRIC), was proposed, and a needs analysis and a cost-benefit analysis were conducted. The results of these analyses suggested that the collaborative GIS center was both an attractive public and private investment.

Having demonstrated the appropriateness and viability of a collaborative approach, six stakeholders in the catchment agreed to establish the HRIC in 1996. Four of these stakeholders represented local industry and community, and two represented state and federal government. The agreement secured the financial and non-financial support of the stakeholders and the HRIC's foundation philosophy of being a non-profit, community-based collaborative GIS facility.

The structure and function of HRIC

The HRIC is a rural, collaborative, community-based GIS initiative. The collaboration helped to foster a spirit of understanding and cooperation between agencies, allowing small organizations to easily access data and expertise. The collaborative agreement, a cornerstone of the HRIC, provides an economy of scale for GIS services in terms of cost and time. It has cost about 25% of the cost of many stand-alone facilities to establish, and was established operationally in half the time compared with industry standards (De Lai, 1997). The HRIC was designed to improve land and water management in the district by providing and allowing access to geographic information, GIS tools, and expertise in an environment that improves communication and collaboration (De Lai, 1997). The objectives of the HRIC are:

- Improved quality of data available for the Herbert catchment
- Improved access to data
- Better informed decisions in planning & implementing data collection & use projects
- Better informed decisions in natural resource management, and
- Improved collaboration

While its partners collect data and undertake programs, the HRIC acts as a GIS consultant, project manager, facilitator, and coordinator. This cooperative approach decreased costs of duplication, and ensures a complete and timely data set that meets users' requirements and business needs (De Lai, 1997). However, the ownership of the projects remains with the partners. Another important function of the HRIC is to provide education and training by providing an opportunity for the community to develop a capacity for spatial science and technology. The provision of professional courses and subsequent support made it possible to achieve a high level of participation from the partners and community. The four stakeholders of local community and industry provide all the funding for the HRIC (Walker et al., 1998). The other two stakeholders, the state and federal government, support data and some technical skills.

The structure of the HRIC is a distributed cross-organizational corporate GIS, intended to result in a genuinely community-based GIS initiative (Figure 3.3). The center has center managers consisting of two full time GIS specialists. They provide expertise and skills to facilitate the collection, storage, maintenance and analysis of natural resource data, and ensure that the products of these activities are delivered to HRIC stakeholders. The role of each partner is as follows.

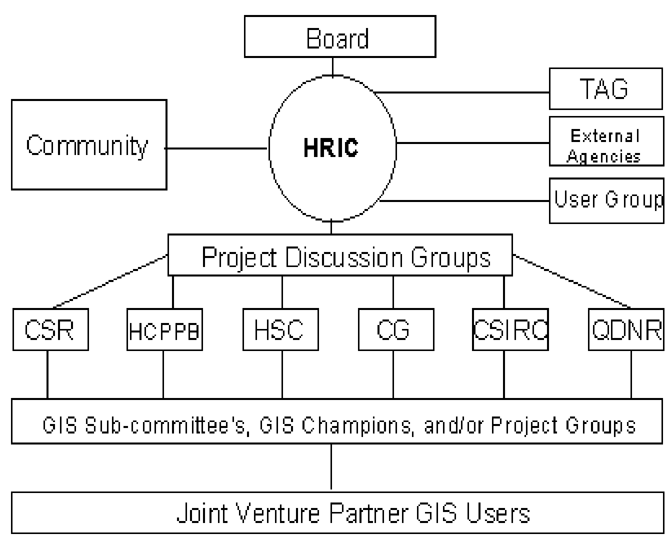

Figure 3.3 The structure of HRIC (De Lai, 1997)

- Board (high level representative from each of the partners): provide strategic direction to the HRIC
- Technical Advisory Group (TAG): a group of individuals from each partner that have specialist skills
- Project Discussion Group: for each major GIS project that the HRIC partners undertake, there is a discussion group. For example, a Sugar Cane Mapping Discussion Group (SCMDG) facilitates the capture of an industry wide geographic data set that meets the needs of more than one organization, and funds a data capture and maintenance program for sugar cane blocks.
- GIS Group: it is responsible for planning their GIS work and implementing GIS as an enterprise system in their organization

Concluding comments: advantages/disadvantages

This approach of neighborhood GIS center is rare, but could be an ideal environment for collaborative participation and decision-making (Leitner et al., 1998). A neighborhood GIS center set by the community groups provides those groups with access to pre-existing databases and to input information gathered by the communities themselves. Commitment to joint projects of the HRIC case in Australia was directly related to a sense of control and ownership of resources information, and involvement in the decision-making process. Designed to meet the needs of the community members, not of other stakeholders, the center provides economies of scale in terms of money, time and expertise. According to the HRIC (Walker et al., 1998), the benefit-cost analysis indicated an overall ratio of discounted benefits to discounted costs of 8.8:1. The collaborative community GIS of HRIC reduced duplication and costs, and facilitated a framework for successful data exchange and maintenance. The success of HRIC was made possible by virtue of the skilled professional staffs employed by the center, the 'neutrality' of the center, which is not viewed as being overly aligned to any one of the partners in the venture, and the credibility to maintain and enhance commitment (Walker et al., 1998).

However, this PPGIS approach is difficult to realize because it requires collaboration in advance of GIS implementation. It will be less accessible geographically compared to the community-based in-house GIS facilities. Significant external funding must be secured. As a communal facility, conflicts between community groups are inevitable. In addition, information from one organization may be not appropriate to other organizations, reducing effectiveness of sharing expertise and data between community organizations. The HRIC was concerned with issues of tightening data access policy and of intellectual property and liability. Finally, as a demand for the HRIC's services grows rapidly, prioritization of tasks and effective restriction of access to services was necessary to avoid serious over-commitment and the danger of failing to meet critical objectives (Walker et al., 1998).

Chapter 4. Comparisons of Case Studies

The previous chapter examined four case studies, each using a different PPGIS approach to apply community-based environmental planning to enhance public participation. Although all case studies emphasized involving community members in the planning and decision-making process, they used different approaches and resulted in different effects. This chapter analyzes the four PPGIS application approaches based on the analytic framework discussed in the second chapter. The three dimensions analyzed are database and GIS system issues, implementation of PPGIS, and community involvement and level of public participation. Table 4.1 summarizes the analysis of the four case studies based on the three dimensions. As indicated in the previous chapter, this analysis is to compare and investigate advantages and disadvantages in relative terms among case studies, not to measure or assess each case study.

Databases and GIS systems issues

In the community-based PPGIS of Southern Ghana case, the community had ownership of the data and GIS systems so that they could tailor data and information to their needs. The data could be directly and quickly available to community groups in this PPGIS approach. Community members would actively use GIS and databases because of the community's ownership, the improved accessibility, the community's ability to manipulate data, and the flexible availability to community needs in the community-based PPGIS approach. However, the quality of data collected and final products was uncertain due to a high possibility of errors during the input process performed by the community members. In some cases, this uncertainty of data and product quality may lead to significant problems. On the other hand, the community groups in the UIC/Pilsen community partnership PPGIS had easier access to expertise about GIS and data from the University. However, their strong dependence on the University and absence of ownership resulted in a low ability of community groups to manipulate data, less flexibility available to their needs, and the community groups' passive use of the database and GIS. The Web-based GIS provides direct access to spatial data and offers two-way interactions, although sometimes it depends on how the Websites are designed and maintained. The neighborhood center was the most ideal approach for community groups in terms of all database and GIS systems issues. Because the center established by the community groups owns the data and GIS systems, community members can easily access them, manipulate data according to their needs, and quickly update data when they need to change it.

Approaches / Dimension	**Community-based GIS**	**University/ Community Partnership**	**Web-based GIS**	**Neighbor-hood GIS Center**
Database/GIS systems				
Community's ownership	High	Low	Low	High
Improved accessibility	High	Medium	High	High
Ability to manipulate data	High	Low	N/A	High*
Quick/flexible availability to community needs	High	Low	High	High
Level of active use	High	Low	Medium	High
Data/product quality	Low	High	N/A	High*
Compatibility with other types of tools	Medium	High	Medium	High
Implementation				
Efficiency (Simplicity/ speed)	Low	High	High	Medium
Level of community's capacity to use GIS independent of experts	Medium	Low	Low	High
Community's cost-effectiveness	Low	High	High	Low
Compatibility with cultural/social structure	High	Medium	Medium	High
Service for education/training	Medium	Low	Low	High
Sustainability of operating/maintenance	Low	Medium	Medium	High
Community Involvement in the process				
Data collection	High	N/A	N/A	High*
Identify problems/issues	High	High	High	High*
Analysis	High	N/A	N/A	High*
Decision-making/problem-solving	N/A	N/A	High	High*
Potential to reach the highest level of public participation	Medium/High	Low	Medium	High

High, Medium and Low indicate the level of the given factor.
High* indicates that given factor has the potential to achieve a high level.
N/A = Not Applicable, that is the given factor does not apply to the given approach.

Table 4.1 Summary of four PPGIS applications

Implementation of PPGIS

The implementation of PPGIS refers to the efficiency of practicing PPGIS, specifically, examining the simplicity of developing the PPGIS process, community's capacity to use data and GIS systems independent of experts, the costs to the community, the compatibility with cultural and social structure of the community, the services of education and technical training for the community, and the operation and maintenance of the GIS systems.

Although the community groups of Southern Ghana participated in developing GIS maps, it was not possible without the aid of external experts. Barriers to implementing GIS are the community's purchasing costs, lack of expertise, unstable funding sources, and the difficulties of long-term maintenance. However, the community-based PPGIS of Southern Ghana could be compatible with the cultural and social structure of communities by involving the community in the data collection process and subsequent group discussions. On the other hand, in the UIC/Pilsen community case, the process of implementing GIS was fast because the University provided GIS expertise directly to the community groups. The dependence on the University for GIS analysis did not require community capacity to use data and GIS as well as community involvement in GIS analysis. This approach cannot incorporate local knowledge, culture, and social perceptions of the community to the GIS, because the University faculty and students may not fully understand the community needs. Instead, the community was benefited by virtue of both lower monetary costs and costs associated with learning and maintaining the system. The Web-based PPGIS showed similar results to the University/Community partnership approach in the implementation issues. In spite of a high internal or external funding requirement, the neighborhood GIS center of Australia provided the ability to achieve higher community capacity and compatibility with cultural and social structure of the community due to community-based collaborative efforts between partners. Providing continuous services for education and training are important issues, considering that the average citizen lacks basic skills and knowledge about geographic data, maps, and GIS systems. Among the four PPGIS approaches, the neighborhood center provided the highest quality of those services.

Community Involvement and level of public participation

Despite poor political, social and institutional conditions, the community-based PPGIS in Southern Ghana incorporated local knowledge into GIS by involving community members not only in gathering GIS data and developing local fire hazard maps but also through subsequent group discussion sessions. In this respect, based on the six levels of public participation ladder suggested by Kingston, this case study falls on the public participation level, "public participation in defining interests, actors and determining agenda." Depending on the purpose of a project, the community-based PPGIS approach would be able to reach the highest level of public participation ladder, involving the community groups in the final decision-making process.

Using different visualization tools, the UIC/Pilsen community partnership helped community residents identify the environmental problems and design the future community environment. Three different visualization tools facilitated a "bottom-up" planning process by allowing the community members to address their perceptions, issues and ideas. Since the public was involved in discussing possible decisions for community's future environment, the UIC/Pilsen community partnership PPGIS approach moved further up to the level of "public participation in assessing consequences and recommending solutions." However, this approach seems inappropriate for the community groups to participate in the final decision in that the approach itself does not lend towards groups participating in the final decision.

On the other hand, the Virtual Slaithwaite using web-based GIS encouraged public participation by allowing community residents to input their comments anytime and anywhere. The Virtual Slaithwaite as a simple exercise of Web-based PPGIS reached the level of "public participation in assessing consequences and recommending solutions." The Web-based GIS approach has a potential possibility to reach the final level of public participation, involving community groups for a final decision, if properly designed and managed.

As a collaborative community-based PPGIS approach, the HRIC GIS facility provided improved quality of and access to data and information needed by the local people, and provided education and training through successful collaboration. Although the exact level of public participation in this PPGIS approach depends on the individual type of project, it opens a possibility of reaching the final public participation level.

Chapter 5. Conclusions: Lessons Learned

The concept of a Public Participation GIS (PPGIS) stems from criticisms of authoritative GIS, which inevitably excludes stakeholders who do not have access to geographic data information or are not familiar with maps in the analysis process. In response to these problems, a PPGIS aims to empower communities by widening public access to data and facilitating public participation in the planning and decision-making process. In this paper all four case studies showed some success in PPGIS applications. Each case study provided opportunities of PPGIS to enhance citizen involvement, thus moving up on the level of public participation ladder, through different approaches and methods. The cases include joint data collection and subsequent group discussions (community-based PPGIS in Southern Ghana), community involvement in discussion workshops using different visualization tools for designing future community (UIC/Pilsen community partnership PPGIS), a Web-based PPGIS, allowing direct access and public input anytime and anywhere for local environmental decisions and planning issues (Virtual Slaithwaite in UK), and a neighborhood GIS center, providing improved data access and quality, a sense of ownership to the community groups, and education and training (Herbert Resource Information Center (HRIC) of Australia).

The paper analyzed case studies with three dimensions in terms of database/GIS system issues, implementation of PPGIS, and community involvement in the process. The community groups in the community-based GIS of Southern Ghana and HRIC of Australia had advantages of improved accessibility, community's proactive use of data and GIS systems, quick and flexible availability to community needs, incorporation of cultural and social structure of the community, and consensus building. These benefits were possible by virtue of a sense of community ownership of the data and GIS systems. The UIC/Pilsen community partnership PPGIS was the most cost effective approach for the community and provided high data and product quality, whereas Virtual Slaithwaite provided improved data access (24/7 access) and allowed community members to input their ideas and comments. Although the HRIC GIS facility required collaboration before implementing PPGIS and significant internal or external funding, if properly managed, this approach can benefit community groups in terms of all other factors.

There is no universal recommended PPGIS approach. As Leitner et al. (1998) acknowledged, community groups do not just choose one approach, but draw on different ways of gaining access to GIS, changing their strategies over time and perhaps developing novel ways of accessing and utilizing GIS. However, the paper can draw some implications on which components of approaches can be best fitted to some particular community and environment situations. There is no doubt that a community-based PPGIS approach is appropriate in situations where the local knowledge and perception is relevant. Examples of this include local forest management, as the case study of Southern Ghana showed, also, fishery or ocean natural resource management, wildlife protection, biodiversity, and identifying water contamination. A partnership PPGIS of a university and a community is the most prevailing approach due to community groups' limited budgets and personnel. A Web-based PPGIS would be useful in dispersed rural areas where it is difficult for community members to attend at a particular time or place. A neighborhood GIS center will be well suited for watershed management protection where the boundary of the watershed is across several communities. A GIS center would promote collaboration among stakeholders, including government agencies and community groups, while providing economies of scale, education and training programs, and high quality of data and information for analysis.

One of the main motivations in implementing PPGIS is the empowerment of community. Whether PPGIS approach can empower community members is one of the critical issues within context of PPGIS. Improved public participation alone cannot guarantee empowering community members. Empowerment means that the community groups as independent actors have the capacity of conducting their own analysis and developing their own agendas for a better decision. It is associated with such factors, used in the analytic framework earlier, as community's ownership of data and GIS systems, improved accessibility, highly active use of database and GIS systems, community capacity to use GIS independent of experts, and continuous services for education and training. Based on the analysis discussed in the previous chapter, the two approaches, community-based GIS and neighborhood GIS center, have potential as tools for empowering community members. In a community-based GIS approach, although they worked with external experts in their first project, community groups could be empowered through a bottom-up approach if they are provided with continuous education and training programs. On the other hand, a community-based neighborhood GIS center could provide a high potential of empowering the community not only because the community owns the data and GIS systems but also because the center can provide high quality education and training services. However, it is important to keep in mind that the key factor to success in establishing the center was collaboration between partners.

The paper concludes with a discussion of what should be considered for successful and sustainable PPGIS applications that facilitate public participation, integrate local knowledge, and empower a community in the community-based environmental planning and decision-making process.

First of all, the context of PPGIS practice is intricately linked to the nature of community participation. Even though all four case studies illustrated the possibility of successful PPGIS to facilitate public participation, it is not easy to achieve original objectives. Political and bureaucratic tendencies may impede meaningful public participation. Moreover, one can raise a question on whether communities are willing and ready to practice and participate in developing PPGIS. However, PPGIS applications imply that in the future GIS would be understood as a means for enhancing public involvement not as a technology itself.

The limited funding sources and costs to apply GIS to the environmental protection are the primary constraints for community groups adopting GIS technology. While it is possible for a community group to develop GIS capacity in-house, it would require enormous internal and external funding sources both in the short-term and the long-term. In addition, lack of time and skilled personnel may impede the adoption of PPGIS. Because it requires lower costs to a community, a university/community partnership PPGIS is likely to remain a dominant PPGIS approach. However, the university/community partnership PPGIS approach is not necessarily a community-driven PPGIS. It has strong dependence on university experts, who may not have a long-term commitment or may not fulfill community’s needs and issues. Because these experts directly participate in the analysis, community members do not receive the education and training necessary for empowerment. Therefore, this approach requires supplemental actions for responding flexibly to communities' needs and knowledge as well as for providing education and training programs in the long-term perspective.

Finally, a PPGIS method should be considered in political and social perspectives, in terms of who has control and access to data and information, rather than the technology perspective itself. For instance, as computers become more widespread the use of Web-based GIS is likely to increase. However, using the Internet may create a new access problem, called "digital divide." Accordingly, Web-based PPGIS must consider those who are excluded from access to data and information. In addition to the data access issue, the Southern Ghana case study showed that the cultural and traditional practices of the indigenous people and unequal representation and participation of women could hinder the successful implementation of PPGIS projects. Although improvement of technology itself (e.g., user-friendly GIS and easy access to data and information) can improve public participation, understanding the political, social and cultural impacts and relationships between GIS technology and users is critical for successfully implementing PPGIS.

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