# WEB-BASED GIS AND THE FUTURE OF PARTICIPATORY GIS APPLICATIONS WITHIN LOCAL AND INDIGENOUS COMMUNITIES

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# ABSTRACT

As resource managers search for strategies to meet the challenges posed by intense competition for scarce local resources, the implementation of Community-based GIS applications have become widespread. Besides mapping, the Participatory GIS (PGIS) projects create a peaceful medium for community groups and public officials to meet, exchange views and also learn to develop trust for each other. However, the PGIS projects face many problems including the lack of basic supporting infrastructure and services. The adoption of the Internet as a platform for PGIS applications therefore raises concerns about the future of PGIS projects. While the Internet may open the participatory process, it can also hinder participation among local groups. In an era when PGIS applications have become important in the management of local resources, there is an urgent need to examine implications of the On-line PGIS project. Accordingly, in this paper, we assess the potential benefits and drawbacks of on-line PGIS applications within local communities.

**KEY WORDS**: Internet GIS, On-line GIS applications, Participatory GIS applications, Community Resource Management, Developing countries.

## 1. INTRODUCTION

Intense competition for scarce resources among groups in local communities around the world is inducing joint action in the management and allocation of resources. This is more severe in former colonized states of Africa, Asia, and Latin America where the assumption of authority over rural lands by colonial powers and later by newly independent nations dislodged traditional land owners and caused the demise of traditional resource management institutions (Walker, 2002). It appears that the usurpation of the powers of traditional institutions did not only leave community resources unprotected but also, the action produced an attitude of confrontation and reciprocal mistrust that has since plagued relations between community groups and public officials of the new states over local forest resources (ibid.). The resulting struggle for ownership and control over the resources has created conflicts in resource accessibility that threatens peaceful development and use of the resources. Also adding to the pressure on local lands are poverty, rapid population growth and attendant increases in demand for resources. As a result of these and other problems, natural resources allocation decisions have become contentious and complex. Resource managers in many communities are expected to address conflicting interests and concerns of citizens when they attempt to allocate and manage the resources.

As the complexity of resource policy decisions has increased, the managers have found a need for new approaches, information and new analytical tools to integrate the multiple interests and viewpoints of stakeholders in official decision making (Walker, 2002). The difficult task of allocating resources among multiple and often antagonistic interests, and the lack of consensus on resource policy decisions has created a need for collaboration between public officials and local community groups. It has become clear that partnerships between statutory and customary 'owners' of the resources are critical for achieving peaceful and effective resource management in the communities (Purnomo et al., 2004). Public participation has therefore undergone revival in resource management institutions. This renewed support for public involvement comes at a time when access to information and technology has, in the advent of the computer revolution, become important in the struggle for equity and representation in official decision making processes. Geographic Information System (GIS) applications have consequently become critical conduits in the public's quest for information on the resources and participation in official decision making processes. Within the context of GIS applications, the revival in public participation has taken the form of a movement known generally as Participatory GIS (PGIS). This new GIS initiative aims to develop a system that is "adaptable to inputs from ordinary citizens" and other non-official sources (Obermeyer, 1998, 65). In several communities around the world, PGIS applications complement grassroots efforts that advocates make to empower less privileged groups who are struggling to make an impact on local politics in order to effect a meaningful change in their lives.

Accordingly, PGIS projects have been adopted to protect indigenous land rights (Jarvis and Stearman, 1995; Nietschmann, 1995), record and appraise local knowledge (Nietschmann, 1995) mitigate resource conflicts (Kyem 2006), and to assess local needs (Craig and Elwood 1998; Ghose, 2001). Other community-based GIS applications have sought to increase community access to information and resources (Elwood 2002; Laituri, 2002), incorporate local knowledge into national land reforms (Harris and Weiner, 2003: Weiner et al., 1995) and enable a broader and more effective participation of marginalized groups in the decision making process (Smith and Craglia, 2003; Sawicki and Craig, 1996). GIS and related spatial technologies have therefore become invaluable tools for creating access to information, political access and legitimacy to underrepresented groups in the society.

In spite of the fact that PGIS applications have become popular channels for local community involvement in the resource management process, the expanded involvement of communities with little experience in the use of such complex technologies generates a great deal of concern (Dunn and Townsend, 1997). There are barriers regarding language, cultural and political traditions and a lack of basic infrastructure that must be overcome in the implementation of PGIS projects (Kyem, 2002; Martin and Lemon, 2001). The recent adoption of the internet as a platform for PGIS applications therefore adds to the complexity of problems experts encounter in the implementation of PGIS into the Internet technology thus raises many unanswered questions:

- Will the integration of the Internet into PGIS applications enhance, or curtail the participation of community groups in Resource Management activities that include GIS?
- To what degree will on-line PGIS applications promote free and unfettered interaction between stakeholders and resource managers?
- Will On-line PGIS applications open up future resource planning and decision making processes beyond what they are today?
- How will the Internet display of collaborative PGIS applications transform community participation and collaborative resource management?

Answers to these questions have become critical because of the prominent role PGIS applications currently play in resource management activities that occur in communities around the world. In a broad sense, Participatory GIS involves the creation of maps with the help of GIS and other spatial technologies often with the involvement of supporting

organizations such as Non-Governmental Organizations (NGOs), universities and activists engaged in economic development and land-related planning. The PGIS project uses a range of approaches including mental mapping, participatory sketch mapping, transect mapping and participatory 3-dimensional modeling that are commonly associated with Participatory Learning and Action (PLA) initiatives (IFAD, 2009). These participatory strategies are reinforced with more technical tools including Geographic Information System (GIS), Global Positioning Systems (GPS), aerial photographs, remotely-sensed images and other computerbased spatial technologies (ibid). Unlike traditional applications of the technology, PGIS projects to provide a critical complement, and not a substitute, to efforts that GIS experts and advocates make to empower community groups. PGIS projects tend to emphasize the participatory process by which outcomes of the GIS applications are attained. The production of maps and analysis of spatial data in a PGIS application are therefore necessary to the extent that they facilitate participatory processes that are intended to open up the decision making process to the public.

As Harris and Weiner (1996) have pointed out, conditions in the communities (i.e., poverty, lack of basic amenities) that make GIS applications attractive also make it difficult to attain effective GIS adoption. Some authors have consequently argued that since GIS and related spatial technologies were not originally developed for use in communities within the developing world, the technology will harm their culture and traditions (Pickles, 1991; Rundstrom, 1995; Taylor 1991). GIS implementation in local and indigenous communities thus took a long time to materialize. Early progress in GIS development was greeted with criticisms about unequal access to spatial data, technology, and expertise in GIS (Pickles, 1991; Sawicki and Craig, 1996). There were concerns about the adverse impacts of GIS applications on social institutions and organizations. Some authors felt the technology imposes a particular logic, and a special way of knowing and representing nature that precluded local and traditional knowledge (Taylor 1991; Sheppard 1993). For others, GIS presented only the official version of a worldview that was biased toward a scientific, expert, and data-driven representation of reality (Taylor 1991; Mark 1993).

Accordingly, GIS was believed to be contributing to a spatial and social marginalization of communities through the technology's ability to cause differential access to information and technology (Harris and Weiner, 1996). Others critics argued that GIS technology placed unnecessary limits on the freedom of people in underprivileged communities that have a good understanding of their needs but could not verbalize their problems within a context that includes GIS (Metzendorf, 1988). The ensuing debate challenged the traditional turfs of GIS development and applications in every function from data collection to data processing and usage. Ultimately, the synergy between forces of sociopolitical ideology, social activism and public expectation converged and helped to redefine the nature of GIS development and power relations that had until the advent of the PGIS movement, defined GIS research and applications (Forer, 1999). The PGIS movement therefore came into being to represent the vision of GIS practitioners who had developed an interest in the socio-political contributions that the technology can make to empower less privileged groups in society (NCGIA, 1996). PGIS is therefore viewed by many as an alternative to traditional GIS applications with an agenda to empower communities who are often ignored in applications of the technology (Lake, 1993).

It is important to mention that the disillusionment with traditional GIS applications was partly due to the fact that momentum in early GIS development and applications was propelled by technological innovation within the rapidly growing computer industry (Reeve and Petch, 1999). In fact, the thrill which surrounded early GIS development evoked images of progressive environments such that locations (such as rural communities) that gave cause to doubt the appropriateness of GIS adoption were bypassed in early GIS implementation

(ibid.). Thus, beside the unattractive conditions and problems within the communities, the link of GIS technology with modernity discouraged its implementation in local and indigenous communities. Today, history seems to be repeating itself as the PGIS movement is riding on the wings of the same technological innovation to advance its integration into the Internet. A critical review of the impacts that the marriage between PGIS and the internet technology may have on community-based applications of GIS is therefore necessary. The importance of a review such as this is borne out by the fact that the PGIS movement itself emerged out of criticisms that were leveled against traditional GIS applications. It is also true that the restrictive and harmful impacts associated with the integration of GIS into the Internet technology will be most profoundly felt in communities where infrastructure support for internet PGIS applications are currently lacking. Given the widespread adoption of PGIS in some of the most vulnerable communities in the world today, and the rapidity with which the applications are becoming necessary in the management and allocation of local resources, the need arises for us to examine implications of the On-line PGIS project. More importantly, we need to be aware of how the On-line applications of GIS will affect public participation, collaborative resource management and the empowerment of individuals and groups within local and indigenous communities around the world.

In addressing these questions and concerns, we begin by examining the potential benefits and drawbacks of the On-line PGIS project. The first part of the paper is devoted to a review of PGIS applications in resource management. Thereafter, we discuss potential barriers to a successful implementation of Online PGIS projects. The discussion occurs in full recognition of the challenges posed by ongoing innovations in GIS and information technology, the complexity of participatory and collaborative interactions and the unattractive environments for technological transfer within the communities. We conclude with a discussion of potential benefits of the Online PGIS project.

#### 2. COMMUNITY-BASED GIS APPLICATIONS IN RESOURCE MANAGEMENT

Given the conflicting nature of the resource management process today, and the pluralism of local communities, traditional resource management approaches are no longer effective for achieving consensus that is necessary for peaceful and effective resource management. Intense competition for resources among individuals and groups in local communities has generated new requirements for spatial data on local resources and analytical tools that support GIS applications. GIS technology offers capabilities with which resource managers can adopt to create and alter resource plans and also incorporate new conditions when environmental conditions change. The managers can also gauge responses to planning outcomes before such policies may be implemented. In addition, the community-based GIS applications come with a set of tools for gathering, analyzing and disseminating spatial data on local resources. PGIS applications may also involve audio, video and three dimensional viewing of virtual reality simulations of resource problems to facilitate common interpretation of features and events. The applications can prepare stakeholders for collaboration because if the technology is applied effectively, it can facilitate the interaction between local groups and public officials who manage the resources. The PGIS applications are not only helpful in facilitating public participation in the decision making process, but also useful when communicating the outcome of a joint resource management process to the general community (Elwood, 2002).

Furthermore, when common objectives are clearly laid-down beforehand, PGIS applications can create a peaceful medium for stakeholders to exchange views about their values and interests, see results of the choices they make, and also learn to develop trust for each other (Kyem, 2006). When applied ethically, the technology can attract a high level of credibility and impartiality, and because it is linked to centers of power and influence in

society, the GIS applications can bring needed recognition to the community-based resource management process. A PGIS application can be used to highlight distinct geographies for different types of resource problems. For example, the parameters of a resource (i.e., land) that is under contention can be mapped so that meaningful discussions based on a shared knowledge of the actual conditions that sustain the disagreement can take place. It is therefore not surprising that, at a time when traditional resource management strategies have proven to be ineffective, PGIS applications have rapidly expanded into local resource institutions. The benefits notwithstanding, adoption and use of GIS in resource institutions within local communities has not been without problems. In many of the communities where PGIS projects are implemented, basic infrastructure for GIS applications is lacking. The high level of illiteracy among the people and a preponderance of traditional and customary practices that are often at variance with the use of advanced Western technology could limit the effectiveness of PGIS applications (Kyem, 2001). It is partly due to these and other problems that the recent attempt to integrate the Internet into community-based GIS applications raises many concerns. In the remaining sections of the paper, we discuss obstacles, challenges and potential benefits of the on-line PGIS project.

#### 2.1 Internet Connectivity and Access to On-line PGIS Applications

An on-line GIS (also called Web GIS or Internet GIS) is a network-based geographic information service that utilizes both wired and wireless Internet to access geographic information and analytical tools in delivering GIS services (Peng and Tsou, 2003; Tsou, 2004). An Internet GIS makes it possible to add GIS functionality to a wide range of networked computer applications. Individuals with an internet connection are able to access GIS applications from their browsers without purchasing proprietary GIS software. The web-GIS is different from running proprietary GIS software over Local-Area Networks (LANs) or intranets on a limited number of standalone computers. The online PGIS project moves the participatory process from isolated, standalone computer systems to networks of individual computers that are linked to a common server. Accordingly, the Internet GIS opens up new horizons of access to spatial data on local resources. The Web GIS technology provides the capability to integrate data from disparate sources and also makes the data and other products available before, during and after the PGIS project. Online PGIS applications allow affected and interested individuals to participate in official decisions from remote locations using the internet as the medium of interaction. Compared to standard GIS software, Internet-based mapping systems are simple, responsive, and also low cost (Vermes, 2006). The system also remains accessible to anybody with an internet connection at any time of the day.

Although the Internet holds great promise for on-line PGIS applications, some observers believe that lack of internet connections pose a great threat to the participation of groups from underprivileged communities (Tsou, 2004). Recent reports on global access to the internet reveal that even though digital information resources are currently available at low or no cost for high speed delivery to people who are connected to the internet, the majority of the world's population remains either poorly connected or not connected at all to these networks (ITU/UNCTAD, 2007; ITU, 2006). A report on global internet usage issued by the International Telecommunications Union (ITU) in 2006 showed that about a third of Europeans (29%) and Americans (28%) had access to the internet in 2004. On the other hand, only 8% of the people in the Asia Pacific region and 2% of Africans had access to the internet (ITU, 2006). The report also revealed that more than 97% of the world's broadband subscribers in 2006 lived in Asia-Pacific, Europe and North America, while Africa had only one percent broadband connection (ITU, 2006). The most recent record of internet usage by geographic regions contrasted with the populations of those areas is presented in Figure 1.





The figure reveals that the world is currently separated by major differences and disparities in access to the internet. North America, Europe and Oceania/Australia are well served as the proportion of internet users is higher than non-users in each geographic region. On the other hand, Africa, Asia, the Middle East and the Caribbean regions are underserved as the number of people without access to internet far exceeds those with connections to the internet. Collectively, the total number of Internet users outside the developed countries in Europe, Australia, Asia and North America account for less than 20% of all internet users worldwide.

The latest global internet use report published by Internetworldstats also reveal that internet penetration rates for North America, Europe, Oceania/Australia and the Caribbean regions for 2009 far exceed the world average penetration rate of 24%. Once again, the geographic regions of Africa, Asia and the Middle East, where the majority of the world's poor people live, have internet penetration rates far below the world's average. As shown in figure 2, Africa has an internet penetration rate of only 5.6%. This is five times lower than the world's average internet penetration rate. According to the critics, the uneven development of structures for Internet access around the world means that a large number of people (particularly those in developing countries) will experience limited or no access to Online PGIS applications. Consequently, many of the intended beneficiaries of PGIS applications could experience very limited participation in Online PGIS projects.



Source: Internetworldstats.com, 2009.

#### 2.2 Technical Challenges to Online GIS Operations

In addition to the accessibility problems discussed above, some observers are wary of technical difficulties regarding performance, technological integration, security and interoperability that arise from designing and implementing GIS capabilities over the internet (Anselin et al., 2004; Tsou, 2004). Some authors are of the opinion that despite the promise of GIS Web services, interoperability among GIS programs and data sources is far from being seamless (Peng, 2001; Tsou, 2004). Full integration of geospatial data and technology with the Internet requires common sets of standards (Fonseca et al., 2006). Thus having multiple vendors, varied data standards and differences in technology (that are common in the Internet and GIS fields) can pose a formidable challenge to the creation of interoperable geoprocessing systems on the web. In fact, due in part to proprietary issues implemented by different Internet GIS programs, data on most servers can only be accessed by their clients (Peng, 2001). The inoperability of on-line servers may prevent real-time data access by participants involved in an on-line PGIS application. It is therefore important that Online GIS software are developed from open architecture so that new components and functions that are compatible to all units can be added easily. The elaborate structures of most spatial data available in raster and vector GIS formats result in large data volumes and because the internet GIS application involves the movement of large spatial objects between a server and many clients over a network, the performance of Internet GIS is often poor (Peng and Tsou, 2003). Added to this problem is the low internet bandwidth (common in local and indigenous communities) which slows the speed of data transfer between a server and its clients. Furthermore, some authors argue that the proprietary and private nature of most GIS software and spatial data pose problems regarding the use of Web GIS (Fonseca et al., 2006; Tsou, 2004). As well, online activities such as data sharing and the transfer of data objects over the Internet are prone to viruses, hackers, and network jams. Copyright issues and confidentiality are also crucial considerations but strategies such as server access protection, data encryption, virus screening, password control and server log-in monitoring that may be adopted to deal with these problems could in turn limit the participation of several people in local communities in Online projects (Dragicevic and Balram, 2004).

Some authors attribute the lack of rigorous web-based GIS procedures for supporting public participation and collaborative interaction to the technical difficulties explained above (Fonseca et al., 2006; Sugumaran and Sugumaran 2007; Tsou, 2004). The critics point to the fact that a majority of current web-based GIS have the most rudimentary capabilities for handling GIS data layers. For example, streets and labels are smashed together in maps created by many online programs and the vast majority of Web maps are marker maps that show specific locations with the clicking of pushpins. It seems however that this state of affairs is changing, but the changes in Web GIS capabilities will take time to materialize. The difficulties entailed in the development of elaborate GIS functions for use on the Web has meant that emphasis in internet GIS has until recently been on map delivery, cartographic presentation and the provision of access to a variety of distributed geographic information

(Peng, 2001). For example, in 2004, Steinmann et al. (2004) evaluated on-line GIS applications in the United States and Europe in terms of procedures for supporting effective interaction among stakeholders. The authors found that only a few of the online GIS projects offered a truly participatory experience where collaboration occurred between stakeholders. The study revealed that majority of the on-line GIS projects focused mainly on data sharing through data clearinghouses that allowed for only one-way interaction.

# 2.3 The Participation Inequality of Online Projects

Some Information and Communication Technology (ICT) experts are also of the opinion that the internet has a tendency to limit participation in on-line discussions to a few professional users (Nielsen, 2006; Shoberth et al., 2003). After reviewing the on-line behavior of thousands of participants at online discussion sites for a three year period, Shoberth et al., (2003) found that only a small minority of participants write most of the online postings. According to the authors, even the increase in the size of on-line communities does not affect the volume of exchanges or the number of participants who exchange views on-line. Rather, the study revealed that, with increasing information load, more and more participants wait around and post little or no message at all (Shoberth et al., 2003). Nielsen (2006) has studied this "participation inequality" and describes it as a typical behavior of on-line communities. The internet communication expert evaluated web usability among small and large scale communities and on-line social networks and concluded that "90% of participants in an online community are lurkers who never contribute to a discussion, 9% contribute a little, and only 1% of the group account for almost all of the postings. Given the potentially high illiteracy levels of PGIS participants and the history of hostile relations between indigenous groups and public officials, community participants will find it difficult to make substantial contributions to online discussions. In this regard, the internet PGIS may create exclusive sophisticated user-communities that are not representative of majority of people in local communities.

## 2.4 Direct, On-Site Communication versus Distant On-line Collaboration

There are also questions about how genuine communication and effective interaction among stakeholders can be maintained in an online PGIS application. According to Van Herzele et al. (2005) direct communication and face to face deliberations often yield better results in collaborative deliberations than negotiations that are based on methods that do not incorporate direct contacts. The authors explain that in a face-to-face interaction, unspoken channels of communication such as nodding, facial expression, eye twisting and supportive sounds (e.g. "ya" "u-huh") are effectively deployed to acknowledge others and show approval and disapproval. These gestures are stripped from on-line discussions where similar acknowledgements occur via multimedia or are written down on a paper. The problem is that the substituted methods (e.g. Internet communication) create records of the inputs from

participants and therefore make it easy for contributions that participants make during online deliberations to be later used against them. Anxiety over the mere thought about a possible revenge may cause individuals and community groups engaged in a PGIS application to rethink their contributions to discussions or even hold back their participation in online discussions.

Cai et al. (2003) have also argued that on-line GIS applications do not allow for utilization of a spectrum of place-based values, interests and concerns that are crucial for the development of culturally sensitive policies that are responsive to socio-political conditions within local communities. The authors explain that a community's culture and history and the collective memory of its people shape the interpretive frames through which the people derive meanings for their actions. But the use of such contextualized human modalities is severely limited in interactions that occur in an online PGIS application. The impact of this drawback become clear when one considers the fact that PGIS applications invite culturally distinct viewpoints, values, and visions from the community. The nature of PGIS projects would seem to require face to face interactions so that people in the communities may understand and also participate effectively in all discussions. The absence of such frames of reference in online PGIS applications from the real socio-political conductions may understand and also participate effectively in all discussions from the real socio-political context and could as well limit the active participation of many people in the communities.

## 3. POTENTIAL BENEFITS FROM ONLINE PGIS APPLICATIONS

Notwithstanding the shortcomings explained above, the internet offers several capabilities that may be adopted to improve community-based GIS applications. The fact that the internet is a medium for conveying a broad variety of content opens up new vistas of communication, collaboration and coordination among individuals, community groups and officials at all levels across the socio-political spectrum (Peng and Tsou, 2003). First, the web makes spatial data more accessible to users who can now retrieve such data from the websites of various data providers, archives and data warehouses. Participants involved in a PGIS project can access data and other useful information prior to their participation in the project. Compared to the proprietary and standalone GIS, Internet-based mapping services are simpler, more user-friendly, responsive, low cost and also accessible to anybody with an internet connection (Vermes, 2006). Free Web GIS services such as 'Google Earth" provide high resolution images that facilitate detailed earth observations and the creation of maps to address community concerns related to their land. For example, high resolution images in Google Earth provide an opportunity to generate information which otherwise would not be available to community groups or may be expensive to procure. Of particular importance is the fact that the remote participation facilities for Online PGIS projects (e.g. computers) are not only available in private homes, but can be assessed in public areas such as libraries or community centers.

## **3.1** A Virtual Space for Public Participation

The second potential benefit is that with online applications, communication and interaction among participants in a PGIS project are not subject to geographic or time constraints. With the Internet, distance away from the location of a PGIS organization is no longer deterrence to participation by affected groups and individuals (Wong and Chua, 2001). Internet GIS has ushered in a virtual space for public participation that is essentially different from the absolute and relative space that existed under place-based PGIS applications. Absolute space is specific and rigid, and relative space is expressed in cost and time within place-based GIS operations. On the other hand, virtual space is an information space where cost and time are no longer the limiting factors to obtaining information and participating in group projects (Wang et al., 2003). In the advent of web GIS, community-based applications of GIS have

expanded to include the ability to click one's way to a destination on the information superhighway (Carver and Peckham, 1999, Wong and Chua, 2001). The virtual space which is offered by Internet GIS promotes free and relatively unfettered communication that is shaped mainly by cultural backgrounds, psychological tastes, the topic under discussion and the message rather than friction from time, cost and physical distance (Wang et al., 2003). Under such conditions, community groups can obtain information and even accomplish complex tasks with relatively high freedom from intimidation and pressure.

Given the universality of the internet, "the public" and "the community" are no longer locally defined (Carver et al., 2001). This is because a community in an on-line PGIS project comprises of individuals who may live hundreds of miles away from the specific location of the project, but respond to issues at a website in cyber space (Kingston, 2002). It is also possible that the network of concerned citizens who may be connected in an on-line PGIS application might include influential members in society who may push the community's resource agenda through the corridors of power to ensure its implementation. Decision outcomes from such open, on-line, collaborative resource planning processes may also be more easily acceptable to a large number of people than would otherwise be the case without the universal access offered by the internet (Carver et al., 2000; Craig, 1988). The fact that the Internet is available all day relieves PGIS practitioners of problems associated with scheduling meetings at times when community groups may either be on the farm, on the market, or engaged in other activities. The 24-hour access to the information and GIS programs opens up opportunities for people to participate in the process at times that are most convenient to them.

#### **3.2** A Novel Forum for Organizing and Hosting Group Discussions

It is also true that place-based group discussions and collaborative ventures promote face-toface interactions among stakeholders. However, distance costs resulting from face-to-face meetings can become a burden for some participants and therefore limit the number of people who may want to attend. Other problems associated with placed-based PGIS applications include costs that may be linked to traveling, organization and facilities arrangements. Some of these costs that are borne before and during the PGIS project are repeated after the project and can therefore add up to create a huge expenditure for organizers and participants in such community projects. The face-to-face interaction strategy is therefore a short-term investment in public participation that may be unsustainable in many local communities. In contrast, Web GIS applications support a sustained public participatory process. This is because the infrastructure and protocols for online PGIS applications become reusable once they are developed (Dragicevic and Balram, 2004). One other drawback of place-based PGIS projects is that majority of the applications are short-lived and as such many completed projects fail to meet their stated goals. The continuous and sustained applications offered by Online PGIS projects remove time restrictions on projects. This ensures that PGIS projects would be implemented over reasonable time periods that allow for the full attainment of project objectives.

Another benefit of the Online GIS project is that the online deliberations among stakeholders focus mainly on maps and the task before the group. The internet avoids many of the interruptions which a face to face interaction among adversaries may produce. It therefore provides a novel forum for organizing community groups where citizens freely interact with other stakeholders without installing proprietary GIS software on their computers. Community groups are also able to express their opinions on issues that affect them in a relatively anonymous and non-confrontational manner. The anonymity may help remove the psychological barrier which often affects participants who engage in such face-to-face discussions (Wong and Chua, 2001). In addition, Online PGIS projects allow for the

opinions of stakeholders to be recorded in real time thereby eliminating the need for reinterpretation that may cause confusion among participants. Moreover, digital maps and the results of Online meetings can be quickly ported to websites to make them accessible around the clock to a vast majority of affected citizens who were not able to attend the meeting (Dragicevic and Balram, 2004).

Web-based PGIS applications may not only change how analysts' access and view maps and spatial data, but the projects will also facilitate the integration of GIS functions into a wide range of internet applications. Web services open up direct access to GIS capabilities that are currently available only by working with a GIS specialist in a standalone system (Adams Business Media, 2001). A Web GIS puts relevant GIS functions on the end user's desktop by embedding them within familiar internet interface applications that are often more user friendly and hence easy to use. Community groups as well as GIS practitioners will not have to understand a proprietary interface in a GIS to embed a code or even use many of the GIS procedures.

## 3.3 A Universal Platform for Multiple Applications

The transformation in geospatial technology from proprietary GIS to Web-based GIS has been slow but the process has picked up speed recently (Wang et al., 2003). The initial response to the growing popularity of the Internet was for GIS software developers to create Common Gateway Interface (CGI) wrappers to the standalone GIS. This allowed for map visualization and simple map query capabilities (Vermes, 2006) but these simple tasks overburdened the thin client/fat-server system and slowed down both data access and geospatial analysis. In recognition of the limitations and with advances in internet technology, the focus of Web GIS development has recently shifted towards clientside GIS which offers more enabling programming technologies such as Java applets, ActiveX Controls and extendable Web clients (Sakamoto and Hiromichi, 2004; Vermes, 2006). The new generation of Web-based GIS facilitates not only public access to geo-referenced information but also the evolution in web GIS technology has led to the rapid development of GIS functions for browsing and analyzing spatial data, resolving conflicts, managing resources and tools for supporting group participation in the decision making process (Sakamoto and Hiromichi, 2004). Web GIS applications have consequently increased and expanded across diverse applications including environmental decisions (Evans et al., 2004; Carver 1999), data dissemination (Anseling et al., 2004), environmental monitoring and hazard mitigation (Yu et al., 2007). Others include decision support (Kingston et al. 2000; Sakamoto and Hiromichi, 2004), business location (Jung and Shun, 2006) and site selection (Evans et al., 2004).

There have also been tremendous improvements in analytical tools for geospatial analyses in Web-based mapping systems such as MapQuest and Google Maps. Besides the remote sensing images and maps, Google-style maps with spatial querying and procedures for supporting complex spatial applications are available to commercial users from companies such as DataPlace which built its open source mapping system using Web technology from Placebase. More rigorous Web GIS functionalities for creating highly legible maps that go beyond pushpins to shaded regions, custom boundaries are increasingly becoming available in online mapping systems. The Google Maps phenomenon has uncovered new users of geospatial information that was never imagined a few years ago. It is possible that the adoption of the internet as a platform for PGIS applications will open up the process to many people, reduce the cost of organizing PGIS applications and also remove time restrictions on PGIS projects. Of particular importance to the participation of community groups in the official decision making process is the capability of the infrastructure for Internet to carry not only data traffic but also graphic, voice and text as well. The convergence of voice communication, data processing, and imaging technologies is ushering in the era of multimedia internet GIS applications in which voice, text, data, and images may be combined according to the specific needs of communities (Sciadas, 2005). With multimedia applications, the inability to read and write may no longer prevent community groups from participating in PGIS projects. Digital compression also allows more efficient use of bandwidth so that the new customers in local and indigenous communities may have more choices and/or lower costs, such as use of compressed video for distance education and compressed voice for Internet telephony (ibid.). The fact that the internet can also be accessed via 3G mobile phones (using wireless technology) that are common in all local communities in the developing world creates a promising future for Online PGIS applications.

# 4. CONCLUSION

There is an interesting convergence that is currently taking place between multimedia, the Internet and spatial information technology. The new development offers opportunities for PGIS practitioners to use the Internet as a platform for hosting GIS applications that occur in local communities. With the integration of the worldwide web into GIS applications, the tools for public participation in collaborative management expand to include on-line procedures for accessing text, audio and video and three dimensional viewing. The capability to use such multimedia in resource management activities can motivate participants, generate high levels of participation in addition to a high responsive feedback participants engaged in a PGIS application. With the internet, PGIS applications in resource management can be programmed as part of an interactive system at a website to expand access to citizens who may be affected by resource policy decisions but may not be physically present at meetings to express their concerns. The internet therefore has the potential to expand PGIS applications in collaborative resource management but the on-line applications can also limit the participation of local groups in the decision making process. Amongst other things, there are concerns about how a genuine communication and effective interaction can be maintained between stakeholders, the mediator and community groups in a web-based PGIS application. The uneven development of structures for Internet access between people in rich and poor communities today means that relatively very little participation in the decision making process will occur among people in poor communities. The integration of spatial information technology into the internet therefore raises prospects as well as concerns for the future of PGIS applications among less privileged people in the communities.

It is however important to note that we live in a global society where the emergence of computers and information technology (including the Internet and mobile phones), and the explosion in digital geospatial data are rapidly altering the traditional modes of human interaction everywhere on earth. It is possible that the forces of technological change will transform traditional approaches to resource management and hence, the way community groups participate in the official decision making process. This optimism is borne out by the fact that recent growth in internet access and usage has occurred in some of the poorest communities in the world (Internetworldstats.com, 2009). For example, while Africa, the Middle East and Central America/Caribbean witnessed 1,100%, 1,296% and 1,490% growths respectively in internet usage between 2000 and 2008, North America and Europe experienced moderate growths of 128% and 274% among internet users during the same period (ibid.). The rapid growth in subscriptions to information technology in poor countries has also been observed in the sale of mobile phones and other wireless telecommunication technologies (ITU, 2006). In addition, several plans are currently in place to extend broadband connections for internet usage to several communities in Africa, Asia and Latin America. Even then connections to the internet via 3G mobile phones could soon become

common in developing countries. These developments in the information technology field provide grounds for optimism in future PGIS applications that take place online.

For PGIS practitioners, the internet provides a means for sharing, maintaining and disseminating data besides the possibility of conducting interactive spatial analysis over the web to expand participatory opportunities to interested parties. We live at a time when information is a vital commodity but the value of any information is determined by timeliness, accessibility, and by our ability to understand and use it. The Internet is a unique plat form for not only distributing spatial data but also for using the data to solve pressing problems. There is little doubt that the internet will exert profound impacts on many areas of human activity of which PGIS application is no exception. Just as plans and strategies undergo changes as they come into contact with modern technology, on-line PGIS applications will evolve in accordance with public expectation, societal demand, and ongoing developments within the ICT industry. Ultimately, the future of on-line PGIS applications in collaborative resource management and other fields would be determined by the choices we make today regarding the internet and spatial information technology, the uses we design for such spatial technologies as GIS, and the institutional arrangements in which the technologies may be embedded in the future.

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