

## Participatory Geographic Information Systems

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## **PARTICIPATORY GEOGRAPHIC INFORMATION SYSTEMS**

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# Participatory Geographic Information Systems

## INTRODUCTION

Geographic information systems are largely used in different levels of administration and planning where georeferenced information is a crucial factor behind analysis and determination of different decision-making scenarios. The potential of these systems is increasingly being perceived as a support to facilitate public participation in planning processes.

Understanding that the incentive to public involvement may come in a variety of forms, e.g. to inform, educate or share administrative decision-making, geographic information systems are a tool that can be improved with interactivity functionalities intended to facilitate information delivery, online discussion and involvement in decision-making.

These interactivity functionalities facilitate public participation, transforming traditional applications of geographic information systems in public participation tools, important for e-government support.

Public participatory geographic information systems (ppGIS) are set up with tools that facilitate citizens' involvement in decision-making related to administration and planning processes. These systems allow information to be disseminated, public reactions to be tested, alternative solutions to be reached and decision-making responsibilities to be shared.

In this paper we present an overview of the main characteristics of geographic information systems and ppGIS, and discuss future trends of ppGIS related to the acquisition and sharing of knowledge. We also identify aspects of learning that

result from ppGIS use and enlighten that ppGIS not only facilitate public involvement, but also comprise tools to support education for citizenship and are means to extend citizens' knowledge constructs in various fields of knowledge.

## **GIS AND PUBLIC PARTICIPATORY GIS**

Information systems use technology to capture, transmit, store, retrieve, manipulate or show information used in different decision-making processes. They can be classified according to the characteristics of the information they use, as for instance Geographic Information Systems (GIS) with their particularity of using georeferenced information (Sá & Aguilar, 2004).

GIS are information systems that enable capture, modelling, manipulation, retrieval, analysis and display of georeferenced data and information (Worboys, 1995). A GIS basically consists of four elements related to the functions of capture, storage, analysis and display of georeferenced data and information.

GIS are critical and important tools to analyze and visualize spatial-temporal information. Originally developed for the creation of thematic maps, GIS support data capture (e.g. digitizing), data storage (database management systems, spatial database management systems), and data analysis (e.g. combination of spatial and non-spatial data) (Visser *et al.*, 2002).

A GIS requires resources related to capture, processing and management of georeferenced information such as:

- Input of data and information from maps, aerial photography, satellite images and other sources of georeferenced information;
- Data storage, search and retrieval;
- Transformation of data, analysis and modelling, including geostatistics;

– Communication of data through maps reports and plans.

Similarly to computer-based information systems, Web-based systems and consequently Web-based GIS offer significant advantages to organizations and users alike as a way of managing and acquiring knowledge as well as filtering information.

These advantages or benefits include creation of value-added goods and services, greater safety, improved service, competitive advantage, error reduction, improved product quality, enhanced communication, efficiency and productivity, greater administrative efficiency, more opportunities, cost reduction, work requirement reduction, greater support to decision-making, greater control over operations and better decision choices (Stair, 1996).

As a function of their geographic scope and ability to support decision-making, GIS come as important tools for e-government applications (Baptista, Silva & Paiva, 2004). Regarded as a support to e-government applications, GIS and particularly Web-based GIS facilitate public involvement, hence them being designated as Public Participatory Geographic Information Systems (ppGIS).

A related work is a research study by Gudes, Stern & Svoray (2004) about the application of a Web-based public participatory geographic information system for Israel planning, whose major purpose is to examine the quantitative contribution of georeferenced information systems in Web environment as opposed to traditional public participation process methods.

ppGIS emerge from two distinct trends, namely technology-based spatial analysis and participatory democracy and are an alternative centred on people, of the use of GIS, which are traditionally centred on technology (Schlossberg &

Shuford, 2005). The purpose of ppGIS is to raise the level of citizens' involvement in planning processes as well as to increase the access to tools, data and information that support decision-making.

Steinemann, Krek & Blaschet (2005) consider four stages of interactivity in ppGIS: information delivery, online discussion, map-based discussion and involvement in decision-making. They also consider that the differences between GIS and ppGIS are grounded in seven elements: focus, goal, organizational structure, details, applications, functions and approach. Table 1 summarizes the topology of those differences.

Table 1: A Comparison of GIS and ppGIS characteristics (adapted from Steinemann, Krek & Blaschet, 2005)

<b>Characteristics</b>	<b>GIS</b>	<b>ppGIS</b>
<i>Focus</i>	Technology	People and technology
<i>Goal</i>	Facilitate official policy-making	Empower communities
<i>Organisational structure</i>	Rigid, hierarchical and bureaucratic	Open and flexible
<i>Details</i>	Specified by technologists and GIS experts	Specified by users and focus groups
<i>Applications</i>	Led by independent specialists	Led by facilitators, group leaders
<i>Functions</i>	General, multipurpose applications	Project-specific
<i>Approach</i>	Top-down	Bottom-up

## **PUBLIC INVOLVEMENT, CITIZENSHIP AND EDUCATION**

Incentive to public involvement may aim to inform, educate, test reactions, seek ideas or alternative solutions and share decision-making (Jackson, 2001).

Public involvement allows rulers to adopt forms that are more consensual and in tune with the interest of the public, particularly in planning processes and in reaching solutions for specific matters.

Information technologies are increasingly being perceived as tools to facilitate interaction among individuals, groups or organizations, thus regarded as means to foment public participation due to their spatial and temporal scope.

Communication mediated by computers tends to reduce the usual barriers of communication among individuals in different hierarchic levels within organizations (Sproull & Kiesler, 1991). Web expansion has come to lift the barriers of communication for ordinary citizens, providing them with facilitating tools to participate at several levels, whether as consumers or more active community members or even impellers of virtual communities.

According to Rheingold (2000), virtual communities can be defined as social aggregations emerging from the Net, where individuals can take part in public discussions, contributing with their knowledge and values to the construction of relationship networks in the cyber space.

Several techniques can help increase public involvement in decision-making. Schlossberg & Shuford (2005) evaluate the participation techniques on a scale of growing complexity that includes static Web pages (simpler technique), interactive Web pages, mail survey, personal survey, public meeting, citizen juries and collaboration (more complex technique). The degree of complexity increases to the extent that the public domain of involvement grows, so simpler stages involve decision-makers only whereas more complex stages also involve ordinary citizens.

ppGIS come as tools that enable the aggregation of several participation techniques into a single application. Although on the one hand this aggregation brings more complexity to the system used, on the other hand it facilitates public participation, allows more individuals to participate, enhances communication between citizens and their rulers and enables the latter to obtain data and information that will deepen and improve their understanding of the communities they operate in.

The use of techniques and participation tools in decision-making improves acquisition of knowledge in various aspects of citizenship education. Citizenship education is grounded in three pillars: knowledge and understanding about becoming informed citizens; developing inquiry and communication skills; and developing skills of participation and responsible action (Selwin, 2002).

A distinction is drawn between “education about citizenship” “education through citizenship” and “education for citizenship” by Blyth (1984):

- Education about citizenship: provides individuals with knowledge and understanding of aspects of national history or aspects of structures and processes of governance and politics;
- Education through citizenship: a form of learning that broadens knowledge and stimulates participation through active experience, at the level of project discussion in the school or community;
- Education for citizenship: a form of learning that combines the previous forms, with involvement of individuals in the acquisition of knowledge, understanding, improvement of skills, values and abilities, through active participation, concern and sense of responsibility in decision-making.

We believe that ppGIS are important tools to attain education for citizenship because they facilitate understanding of governance processes, facilitate participation and discussion and promote acquisition and sharing of knowledge and values.

### **ppGIS APPLICATIONS**

An inventory of experiences that, according to their characteristics, could be qualified as ppGIS is available on the *ppGIS Observatory* Web site (<http://ppgis-obs.scg.ulaval.ca>), which provides information about several ppGIS projects: application subject, date, country and location, short description, publisher, background, conception, objectives, sociopolicy context, participative method, success and failure elements, among other characteristics.

The ppGIS projects of the *Observatory* database address the following application subjects: resource management, sustainable development, urban planning, and conservation. Whilst the conception of those applications is mainly bottom-up, 43% of the projects use the top-down approach. The success elements reported include the useful public inputs to the democratic process since ppGIS has informed and helped the community to express their views and aspirations, the increase of the citizen's awareness about the applications subjects, and an intense interest in the use of GIS. Most of the failure elements reported relate to difficulties with technology and technical constraints, and problems with public access.

### **FUTURE TRENDS: KNOWLEDGE CONSTRUCTS**

Typically, the use of GIS requires knowledge of the domain the GIS applies to, computer skills, knowledge of geographic concepts and GIS specific functions.

The tasks of identifying relevant themes, editing or adding data, layering themes, reporting results and spatial analysis demands specialized knowledge by the end-users (West, 2000).

However, Web-based GIS come as important tools to help users acquire or improve their computer skills, geographic concepts and knowledge about the functionalities of databases and systems. Some characteristics of constructivist learning can be associated with GIS-assisted learning (Bednarz, 1995; Gonzalez, 2002; Sá, Colaiacomo & Aguilar, 2005).

*Constructivist Learning:*

- Learners construct knowledge;
- Learners discover relationships through experience;
- Learners learn in complex, authentic situations;
- Learners manage their own learning;
- The process of learning is as important as the product;
- Learners learn from each other.

*GIS-Assisted Learning:*

- Users construct knowledge through databases and maps creation;
- Users explore spatial relationships through mapping;
- Users learn from real-world data and situations;
- Users guide themselves, identifying relationships through data exploration;
- GIS are tools for exploring;
- GIS make real-world data available to others and help discuss and build a common view.

Similarly, ppGIS constitute important tools for public involvement and education for citizenship because, among other things, they facilitate understanding of governance and politics processes; increase dissemination of information and knowledge of community matters; facilitate communication and sharing of ideas; help construct a “community spirit” as they raise awareness of “community benefits” to the detriment of individual interest (sense of responsibility); help develop argumentation, participation and initiative skills; and improve knowledge about participation techniques and use of technologies.

The use of these tools leads to the learning of topics intrinsic to distinct fields of knowledge, including use of communication and information technologies, use of spatial analysis tools (e.g. Web-based GIS) as well as participatory democracy and citizenship.

In ppGIS-Assisted Learning and according to the foregoing, we identify the following characteristics:

- Participants construct knowledge through public participation and manipulation of information and maps;
- Participants explore social and spatial relationships through ideas discussion and mapping;
- Participants learn from effective participation and real-world situations;
- Participants guide themselves through community values and sharing points of view;
- ppGIS are tools for exploring, participating and taking initiatives;
- ppGIS help discussion and build a common view to take consensual decisions.

Due to their interaction ability, ppGIS can be perceived by rulers as tools to facilitate dissemination of information, test public reactions, seek ideas or alternative solutions and share commitments (between citizens and rulers) in decision-making of interest to the communities.

## **CONCLUSION**

In a general way, Web-based systems offer advantages in comparison with systems outside a network, mainly due to the ease of information distribution, enhanced communication between different stakeholders, cost reduction and better control over operations as well as feedback efficiency when discussing and debating over different matters.

The main difference between GIS as georeferenced information systems and ppGIS as GIS centred on people lies in the interactivity that the latter allow as tools to disseminate information; as a technique to facilitate and boost public involvement in decision-making; and as learning tools in diverse fields of knowledge, be it to improve knowledge and information technology skills or be it in aspects of citizenship and participatory democracy.

In order to reach better understanding of the importance of ppGIS for public involvement and education for citizenship, we referred to characteristics of Constructivist Learning and GIS-Assisted Learning and identified six characteristics of knowledge constructs supported by ppGIS, as a technique that facilitates and promotes public involvement in decision-making.

## **REFERENCES**

Baptista, C., Silva, E., & Paiva, E. (2004). Using Open Source GIS in e-Government Applications. In R. Traummüller (Ed.), *Electronic Government: Third International Conference, EGOV 2004: 3183* (pp. 418-421). Lecture Notes in Computer Science, Springer.

Bednarz, S. W. (1995). Researching new standards: GIS and K-12 geography. *Proceedings of GIS/LIS Conference* (pp. 44-52). Nashville, Tennessee.

Blyth, A. (1984). Industry Education: Case Studies from the North West. In Ian Jamieson (Ed.), *We Make Kettles: Studying Industry in the Primary School*. London: Schools Council Programme 3/Longman.

Gonzalez, R. M. (2002). Joint Learning with GIS: multi-actor resource management. *Agricultural Systems*, 73, 99-111.

Gudes, O., Stern, E., & Svoray, T. (2004). Geographic Information systems on the Web for Public Participation Planning. *Proceedings of the 12<sup>th</sup> International Conference on Geoinformatics* (pp. 459-463). Geospatial Information Research: Bridging the Pacific and Atlantic, University of Gävle, Sweden.

Jackson, L. (2001). Contemporary Public Involvement: toward a strategic approach. *Local Environment*, 6(2), 135-147.

Rheingold, H. (2000). *Virtual Community: Homesteading on the Electronic Frontier*. MIT Press.

Sá, D. M., & Aguilar, L.J. (2004). Knowledge and Information Systems: characterization and development methodologies. In TECSI/FEA/USP, *Proceedings of the 1st International Conference on Information Systems and Technology Management* (cd-rom). Universidade de São Paulo, Brazil.

Sá, D. M., Colaiacomo, L., & Aguilar, L.J. (2005). Knowledge Constructs through Web-based Geographic Information Systems. In IEEE & COPEC, *Proceedings of the Global Congress on Engineering and Technology Education* (pp. 861-865).

Schlossberg, M., & Shuford, E. (2005). Delineating 'Public' and 'Participation' in ppGIS. *Urban and Regional Information Systems Association Journal*, 16(2), 15-26.

Selwin, N. (2002). *Literature Review in Citizenship, Technology and Learning*. Futurelab Series, Report 3.

Sproull L., & Kiesler, S. (1991). Increasing Personal Connections. In L. Sproull & S. Kiesler (Eds.), *Connections: New Ways of Working in the Networked Organization* (pp. 79-101). MIT Press.

Stair, R. (1996). *Principles of Information Systems a Managerial Approach*. Boyd & Fraser Publishing.

Steinemann, R., Krek, A., & Blaschet, T. (2005). Can Online Map-based Applications Improve Citizen Participation?. In M. H. Böhlen, J. Gamper, W. Polasek & M. Wimmer (Eds.), *E-Government: Towards Electronic Democracy: 3416* (pp. 25-35). Lecture Notes in Computer Science, Springer.

Visser, U., Stuckenschmidt, H., Schuster, G., & Vogege, T. (2002). Ontologies for Geographic Information Processing. *Computers & Geosciences*, 28, 103-117.

West, L. (2000). Designing End-User Geographic Information Systems. *Journal of End User Computing*, 12(3), 14-22.

Worboys, M.F. (1995). *GIS: A Computing Perspective*. Taylor & Francis.

## **TERMS AND DEFINITIONS**

**Decision support systems:** A specific class of information systems designed to support decision-makers at any level in an organization. More specifically, decision support systems are the set of technology-enabled systems that support organization processes, and help decision makers to compile useful information in order to identify and solve problems and make decisions.

**e-Government:** Refers to the use by government agencies of information technologies (such as the Internet, wireless devices or other communications systems) to support government operations, engage citizens, and provide government information and services.

**Geographic information systems:** A specific class of information systems designed to capture, storage, model, manipulate, retrieve, analyze and display all forms of geographically referenced data and information.

**Georeferenced information:** Any information about a place, an object or process with a corresponding geographic location or area.

**Knowledge communities:** Structures of social interactions aiming at the generation and disclosure of knowledge. More specifically, knowledge communities are groups of people who share a special interest for a given topic, and who collaborate to deepen their understanding of that topic through ongoing learning and knowledge sharing.

**Public participatory geographic information systems:** Systems that incorporate conventional methods of public participation with geographical information

technologies (namely GIS, i.e. geographic information systems), facilitating the communication between government agencies and social communities.

**Virtual communities:** Social groups communicating or interacting with each other by means of information technologies, typically the Internet, rather than face to face. Virtual communities are also known as online communities or mediated communities.