MASTERS PROGRAM IN

GEOSPATIAL TECHNOLOGIES

THE INTERSECTION OF PEOPLE, TECHNOLOGY AND LOCAL SPACE: PPGIS AND WEB 2.0 IN PRACTICE FOR PARTICIPATORY PLANNING

Geisa Bugs

Dissertation submitted in partial fulfilment of the requirements
for the Degree of *Master of Science in Geospatial Technologies*

UNIVERSIDADE NOVA DE LISBOA

UNIVERSITAT JAUME·I

WESTFÄLISCHE WILHELMS-UNIVERSITÄT MÜNSTER

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Dissertation supervised by

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February 2009

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THE INTERSECTION OF PEOPLE, TECHNOLOGY AND LOCAL SPACE: PPGIS AND WEB 2.0 IN PRACTICE FOR PARTICIPATORY PLANNING

ABSTRACT

This study concerns about the contributions of Web 2.0 tools to Public Participation Geographic Information System (PPGIS) and of PPGIS to participatory planning. Web 2.0 tools are increasingly occupying an important role in the universe of geographic information consciousness. Both Web 2.0 and PPGIS are about decentralization, public mapping, and local knowledge, encouraging throughout productive results. The project develops a Web 2.0 PPGIS mashup application through free, easy-to-use tools. It consists of a Web mapping service, with eligible GI layers, where users explore and comment. A database stores the contributions in a format supported by GIS. Finally, we set a first version at Canela – Brazil, to test the usefulness of the method on a real planning scenario. Results shown it is a valuable approach for engaging the public in participatory planning. It promotes communications among users and with decision makers in a more interactive and straightforward way. The Web 2.0 PPGIS is easy to set and understandable by nonexperts, and can be easily applied on other contexts.

KEYWORDS

Public Participation Geographic Information Systems

PPGIS

Public Participation

Participatory Planning

Web 2.0

Web GIS

ACRONYMS

AJAX - Asynchronous JavaScript and XML

API - Application Programming Interface

CAD - Computer Aided Design

CASA - Center for Advanced Spatial Analysis

GI – Geographic Information

GIS - Geographic Information System

GMaps – Google Maps

HCI – Human Computer Interaction

HTML – Hyper Text Markup Language

IBGE – Brazilian Institute of Geography and Statistics

IIS - Internet Information Services

IT – Information Technology

IPEA* – Institute of Applied Economic Research

JSON - JavaScript Object Notation

KML - Keyhole Mashup Language

NCGIA - National Center for Geographic Information and Analysis

ODPM - Office of the Deputy Prime Minister

PHP - Hypertext Preprocessor

PLHIS* - Housing of Social Interest Local Plan

PPGIS – Public Participation Geographic Information System

RSS - Really Simple Syndication

SAD - South American Datum

SIMMLAB* – Laboratory for Simulation and Modeling in Architecture and Town Planning

SNHIS *– Housing of Social Interest National System

SQL - Structured Query Language

UFRGS* – Federal University of Rio Grande do Sul

URL - Uniform Resource Locator

W3C - Worldwide Web Consortium

WGS - World Geographic System

WMS - Warehouse Management Systems

XML - Extensible Markup Language

* Author's free translation.

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

1 INTRODUCTION

Not so long ago Geographic Information Systems (GIS) through the ability of spatially reference information, changed the way spatial data could be captured, stored, analyzed, managed, and presented. Later, Google Earth virtual globe democratized geography, driving public interest in geospatial technologies (Butler, 2006). Almost related, Web 2.0 services started to allow the public to create and spread their own data on the Web. As a result, there are some maturing terms on the technologies arrivals and its relation with society like Neogeography and Voluntary GIS (Goodchild, 2007).

An increasing amount of the information we now consume digitally is user created, as shown by Flickr, Wikipedia, and YouTube (Hudson-Smith and Crooks, 2008). Differently from the past, when institutions and mapping agencies were the main responsible for geospatial data creation and distribution, now people without technical expertise can easily make a map and publish it online. The distinction between data providers and data consumers dissolves thanks to open editing policies and geodata editing tools. The term Neogeography refers to this use of geographical techniques and tools by nonexperts.

Voluntary GIS is the result of a growing number of exchanges with Geographic Information (GI) enabled by the recent advances on the Internet (Goodchild, 2007). These Internet advances, referred as Web 2.0, are usually freely available and easy to learn effectively without professional expertise need (Hudson-Smith and Crooks, 2008). Thus it let users to do much more than just recover information as previously.

The public is largely making use of Web 2.0 tools. Common examples are the personal blogs, social network services, and Wiki Web servers. The notion of taking technology for the values and interests of the public is seen as an extraordinary transformation in technology (Castells, 2001). According to Castells (2001) one of the greatest surprises is that all the movements expected to be unable to understand modern developments are organizing themselves on the Internet, and are using information technology.

Likewise, gradually the society is being involved at all planning affecting their lives. Mainly motivated by legislations that made necessary to gain public comment before decision making, recognizing basic human rights and that unpopular policy reduce trust (Brink et al., 2007). Rio'92 Declaration[1] promotes public participation to build sustainable development. Local Agenda 21[2] program of United Nations enshrines the practice on its principles. This is known as participatory planning or bottom-up decision making.

[1] United Nations Conference on Environment and Development held in Rio de Janeiro on 1992: tp://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm

[2] Document launched on Rio'92 with a list of actions to be taken nationally and locally for a sustainable development. http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm

Public participation legitimizes the decision making, helps achieve higher effectiveness levels for the planning, and improves the quality of the content since each person has a different view. For Brink et al. (2007) public participation is a mean to increase plans acceptance and make their implementation more effective; and an end to transform, since citizens have the moral right to take part in all decision making that affects their lives. Thus there is a consensus that citizens' involvement is positive for planning and that new technologies should support it (Kingston et al., 2000; Carver, 2001; Kingston and Smith, 2007).

On the other hand, Public participation GIS (PPGIS) is the GIS application to strengthen public participation in decision making, to promote community objectives, and to help communicate some location-based problems (Kingston and Smith, 2007; Sieber, 2006). Since the 90's PPGIS projects stress out the need of techniques to capacitate and empower citizens more because GIS need high technical expertise and the average citizen lacks such skills (Craig, 1998; Elwood, 2006).

1.1 Assumptions

The ideal behind public participation is that of total public control on the decision making. Traditional methods of public participation are not enough since they do not enable exchange of ideas (Brink et al., 2007). They must be complemented. The interrelated trends described previously, are forms of public empowerment. Information is power, and as mentioned, creating, sharing, or accessing GI is no longer a big problem. Given that collaborative projects are multiplying, GI is at popular dominium, and sophisticated tools are accessible, it is reasonable that PPGIS should benefit from it.

This study combines principles of participatory planning, PPGIS, and Web 2.0 tools. Focusing on developing a Web 2.0 PPGIS platform, with tools, techniques and services free available. We believe that Web 2.0 and collaborative GIS technologies, which are already spontaneously adopted by ordinary people routinely, as Google Maps (GMaps) and Google Earth represent, have potential to help improve PPGIS techniques. And that PPGIS can enrich participatory planning techniques, given it great visualization and organization powers.

1.2 Problem Statement

As an emerging field, PPGIS methods are under construction. PPGIS drawbacks still are its fundamental ability to handle GI, communicate, accept, organize and reflect user participation (Carver, 2001). Most significant it lacks means to use the huge amount of user created content. Even though up-to-date research effort is concentrating in new technologies around the Web, the reality is that exchange platforms are exceptions (Steinmann et al., 2004). Also, most of the examples described in literature are still experimental once they corroborate available technical possibilities but do not apply on real participatory planning actions (Hanzl, 2007).

Therefore the reasons for driving efforts to this research are that PPGIS, in general, make GIS and other decision making tools available, but just making available does not ensure participation. Nevertheless it is necessary to capacitate public to deal with GI. Some authors believe that amateurs may be even able to suppress professionals whenever they have the right tools to channel their efforts (Barsky and Purdon, 2006). Recent technological advances may have the potential to improve current approaches, to enable more people to engage more, and to alter their access and use of the GI (Carver, 2001). The changing GI nature, reflecting at Neogeography and Voluntary GIS ideas, ask for new approaches.

1.3 Research Objectives

The study goal is to follow, understand and explore Web 2.0 implications for PPGIS context and of PPGIS for planning. What does Google Earth popularity, network society, and folksonomies culture means for public participation? Can these trends promote people without any expertise to understand and deal with GI more effectively? And even though Web 2.0 solves the two-way flow need, how to collect and manage the large amount of user created content for real use in spatial planning?

This work first proposes to develop a Web 2.0 PPGIS application as a whole: visualizing, editing, saving, and organizing feedbacks. At this point, the study addresses a main PPGIS weakness: help public to express their opinion and, in turn, organize user's feedbacks. For example, professionals shall be able to use the created information for spatial analysis at a GIS environment.

Afterwards it tests the prototype at a real-world participatory scenario, to verify the practical usefulness of the method. This second step concerns about PPGIS for spatial planning decision making in practice. The evaluation workshop wants to verify how the public use, how well they understand, to each extent the application interests them and if it could strengthen public participation for decision making.

The outcome is a Web 2.0 PPGIS or, in other words, a collaborative GI online platform that combines several tools and services. The architecture and functionalities can expand according to the demand. It may serve as a social tool, not only for specific participatory planning, but for e-governance or any spatially related issue involving community. Participation should be a permanent part of the development. So the community can check constantly the planning, the municipality can avoid problems of unpopular policy with community and unnecessary costs, and planners can evaluate proposals on the way (Brink et al., 2007).

1.4 General Methodology

According to the objectives, this project has two parts: first it develops a Web application focusing on the use of Web 2.0 tools to enrich PPGIS. And second tests a preliminary version at a

workshop to evaluate the usefulness of the proposed method for planning. The following subsections describe the method followed to achieve each of these objectives, always considering that changes on the way are unavoidable and necessary.

1.4.1 Web 2.0 PPGIS

Citizens shall use the Web application to produce maps which support their comments. But users created maps are not concrete or right to the point. They are about emotions that reflect the ways in which they identify with the environment. The key to link these emotions is to find the correct interactivity and visualization tools necessaries to create a user-friendly and creative platform. Interactivity implies that it will enable users to have high communication levels with the system (Steinmann et al., 2004). Visualization tools means the methods used to represent spatial data to be easily understood by users. Also it might be suitable for different types of public. Table 1 presents a list of principles and goals and the respective proposed interactivity tool.

Principle		Goal	Interactivity
Information distribution	Experts	Enable the experts to promote the practice.	Add layers, add extra information. Use the user created content for spatial analysis.
	Nonexperts	Provide means, ways and tools to engage.	Visualize mapping service, planning data layers, and extra information.
Solutions through participation		Provide means, ways and tools to increase participation.	Map-based editing and commenting tools.
Transparency		Store, organize and display the evolution.	Store and organize contributions at a database to use in GIS environments.
Consensus building		Support two-way flow of information.	Send comments and see others comments displayed as another layer.

Table 1: List of principles, goals and interactivity proposed (adopted from Tang, 2005)

The context and objectives taking place dictated the functionalities. Thus the prototype will present at the beginning basic functionalities, which can grow according to the needs. It is more desirable to create something useful than something complicated and confuse. Nielsen (2008), based on the theory of social software, explains that nowadays users define what they want of an application with experience of use. Social software obeys to simple mental model shared by all the users and focus in little roles with verified utility for those who use it (Jazayeri, 2007).

The proposed Web 2.0 PPGIS consist of a mapping service as base, with eligible GI layers, where users can explore and enter text comment. A database stores the contributions and organizes them with a format supported by GIS. Urban planning topics organize the layers by color. The comments made appear as another information layer in the related topic. Besides, users can express their satisfaction by labeling the comments made. This role promotes a direct reaction that can be statistically analyzed. Extra spatial information, like reports and sketches, may complete the collaborative platform. Therefore, these simple functionalities provide the means by which the user can:

- Explore GI as map and satellite image formats with the mapping service
- Visualize planning information with the eligible layers
- Express and share their ideas with the commenting tool
- Produce map-based participation
- Evaluate the comments
- See others comments as another layer
- Access extra information and other sources.

The project applies the idea of mashup. Mashup to create a coherent application need programming and knowledge about protocols conventions. However mashup of mapping services are easier since Google made its API (Application Programming Interface) public. Google Maps API allows embedding custom Google Maps at any Website, customizing it and adding data. For various reasons, it would be almost impossible to build from zero all the GMaps available functionalities. So this project adopts Google mapping services. However it could be other services. For instance OpenStreetMap provides free geographic data created collaboratively, but unfortunately had not enough coverage for the implementation context of this application.

1.4.2 Evaluation Workshop

A first version of the Web 2.0 PPGIS will be tested at Canela – Brazil (see 1.4 Study Case) by January 2009, at an evaluation workshop that will take place at a known public place. An observer will take notes on voluntaries performing an evaluation test of the first version of the platform. The goals of this phase are:

- Spread the application within citizens
- Help and capacitate population to use the application
- Note the public pitfalls, annoyance, and satisfaction while using it
- Register users view
- Apply a questionnaire about their tool's opinion and what would they expect more
- Analyze and report the results for future recommendations.

Given that the Web 2.0 PPGIS target public is the whole population, this means a wide range of diverse possible users. Thus we aim to get at least 20 participants at the workshop, for minimum statistical analysis. As much representative as possible: different in age, Internet and GIS knowledge levels, professions and interests. The workshop will have three basic steps: short introduction and user's interview made by a helper person, a user hands on section, and lastly a questionnaire.

1.5 Study Case

Brazil accepts well and recommends public participation for decision making through federal legislation. Since 2001 the law known as Estatuto da Cidade[3] obligates cities with more than 20.000 habitants to have its master plan built with public participation. Earlier, in 1989 Porto Alegre[4] had already adopted the practice for citizens to decide how to assign part of the municipal budget. The city is internationally famous for the first full participatory budgeting procedure.

Apart form it, there are several projects using traditional forms of public participation, with relative good results. But few are using GIS or Web 2.0 technologies. It is true that Internet access could be a barrier. However the increasing numbers of Orkut users, so popular at Brazil, encourages affirming that this may be overcome soon. Besides, local authorities are beginning to promote public Internet access points. We believe Web access may not be problem any longer, as newer and cheaper forms of connection appear.

For instance, Canela – RS is a community on Orkut with 5,927 participants (accessed on 30 September 2008). They have discussion topics such as "Is Canela an expensive city?" About life cost; or "You cannot have a car in Canela", about the street's conditions. It shows that citizens have interest on spatial related issues. Also, that they are already organizing themselves around the Web with the existing tools. Equally, WikiMapia (WikiMapia, 2009) an online mapping that aims to describe the whole world with folk's knowledge, has entries for the town.

Canela[5] is a famous tourist destiny found at 29° 21' 57" S 50° 48' 57" W in Rio Grande do Sul, the south more state of Brazil (Figure 1). It has around 40.000 habitants (IBGE) on 254.579 km^2. Canela had German colonization. The first urban setting dates from 1903. It has limits with Gramado, Caxias do Sul, São Francisco de Paula, and Três Coroas at the called Serra Gaúcha region. It is 123 km faraway the capital Porto Alegre.

The city has been tourist attraction since the 30's. Its climate, relieve and hydrographic resources, at 837m above mean sea level, promote diverse waterfalls and valleys and opportunities for ecotourism (Figure 2). With the neighboring Gramado draw around 1.800.000 visitors each year, especially during winter season, Easter and Christmas holidays. The touristy status gives Canela some special features like high PIB for each person (R$ 5.353,74) comparing to Brazilian standards (IPEA).

On the second semester of 2008 Canela had been developing the Housing of Social Interest Local Plan (*Plano Local de Habitação de Interesse Social - PLHIS*). Giving emphasis to the housing

[3] Brazilian Federal law nº 10.257, responsible by the regulation of the urban development in Brazil. Available at: http://www.cidades.gov.br/secretarias-nacionais/programas-urbanos/legislacao/Lei10.257-01.pdf/view

[4] Capital of the south more Brazilian state of Rio Grande do Sulhttp://www2.portoalegre.rs.gov.br/op/

[5] http://www.canela.rs.gov.br/

question in Brazil and to mobilize town's councils for social housing projects, the Department of the Cities created in 2005 the Housing of Social Interest National System (*Sistema Nacional de Habitação de Interesse Social - SNHIS*). In this way, a Federal law fixed the need of Local Plans of Social Housing elaboration trough public participation.

Therefore, the Local Social Housing Plan of Canela will set regulatory instruments for planning and management of housing. It is a more detailed plan, which follows the strategies of a master plan, and defines an assembly of goals, objective, directives, and instruments that orient social housing projects and programs. To achieve it, several issues have to be analyzed, like social economical indices, growing rate and urban expansion, transport and mobility, environment, and so on. Simmlab - UFRGS [6] made a series of urban analysis studies and diagnosis on these.

Since August 2008, traditional public participation meetings were promoted in four tow's regions based on geographical and social economic aspects. These meetings were coordinated by experts who presented a slide show to the audience. After, they invited the public to express opinions on paper maps, and fill a questionnaire about want they think are the housing problems (Figure 3). The issues raised range from sewer net supply need, to missing health centers, and leisure areas. These meetings produced a report identifying strengths and weakness.

Figure 1. Canela localization (Google maps)

[6] Laboratory for Simulation and Modeling in Architecture and Town Planning: http://www.simmlab.ufrgs.br/. From the Federal University of Rio Grande do Sul (UFRGS*):* www.ufrgs.br/

Figure 2. Parque da Ferradura (Canela Tourism)

Figure 3. Public at a participation meeting (Simmlab)

1.6 Limits and Scope

We will perform the evaluation workshop at Canela thanks to the possibility to develop the workshop during the thesis period. We are open to do it in other places as well. Because of time constrains and Internet access, we do not have expectations on a huge number of participants in the workshop. Also, it will test a first version, so maybe not all the functionalities will be available yet.

Such projects are unlikely to persist unless a community organization or person takes the responsibility. It is out of scope of this project to keep it, although we would like to cooperate and keep working in this field. Finally it does not intend to replace current participation methods but to strengthen it to empower citizens.

1.7 Thesis Structure

Chapter 1. INTRODUCTION brings in the main ideas of this project, the motivation, objectives and methods. Chapter 2. THE INTERSECTION OF PEOPLE, TECHNOLOGY AND LOCAL SPACE describes the interrelated ideas and technologies that underlie the project, its background and

context. Chapter 3. WEB 2.0 PPGIS IN PRACTICE presents related works and explains the Web 2.0 PPGIS developing steps. Chapter 4. EVALUATION WORKSHOP shows the results from the experiment in Canela with potential users. And, Chapter 5. CONCLUSIONS, closes and recommends further work.

2 THE INTERSECTION OF PEOPLE, TECHNOLOGY AND LOCAL SPACE

It is a consensus that GIS and Internet tools can support participatory planning. GIS is of great significance because it is a powerful mediator of GI. The visualization potentials and the capacity to model multiple outcomes are central (Elwood, 2006). Nevertheless, the planning purpose should dictate the technology use and not the technology itself shape the method (Klosterman, 2001). Accordingly to these ideas, this chapter discusses some emerging concepts and technologies, their context and background towards the project.

2.1 Participatory Planning

Public participation is an integral part of planning. The main reason is that citizens know about local problems better than anyone else. They can provide detailed insights into local space description that are not normally available from other sources. So it leads to different solutions than by using purely traditional forms of data. Besides, when public take part in, the chances of the plan implementation are bigger because the proposals are the important ones for the community and thus citizens are more likely to follow and pressure it. It also creates an atmosphere of credibility and confidence within community.

Central to a participatory planning is how to make the ideal solution and how to get consensus. It is not simple, since it deals with ill-defined problems, which have an infinite number of solutions, and the problems co-evolve with the solutions (Webber and Rittel, 1973). The solution may emerge gradually from both experts and nonexperts with continuous judgment (Tang, 2005). It is a complicated progression, where environmental and socio-economic reasons have to be balanced against each other (Webber and Rittel, 1973; Tang, 2005).

On the other hand, it is necessary to make sure that official and informal discourses are connected. Brink et al. (2007) explains it is not simple to embed participation practices into existing institutional framework. It is obvious that there is resistance, lack of qualification, and even, interests acting as barriers when government starts to enable people to take the initiative or resistance towards developments (Brink et al., 2007). Also spatial planners must be open to citizen's opinions. Table 2 summarizes some factors of planning culture influencing citizen's participation.

<table>
<tr><td rowspan="2">Local authorities: Aware of the merits of citizen participation? Experienced in organizing participation? Willing to organize informal participation practices? Willing to consider citizens ideas in decision making?</td><td>Central-local government relation</td><td rowspan="2">Planning culture</td><td>Tradition of democracy</td><td>Citizens: Aware of the possibilities of participation? Motivated to engage? Experienced in democracy? Trusting authorities?</td></tr>
<tr><td>Legal needs</td><td>Approach to spatial planning</td><td>Spatial planners: Ready to cooperate with laypeople? Skilled in promoting participation? Skilled in using innovative methods and techniques?</td></tr>
</table>

Table 2. Factors of planning culture influencing citizen's participation (adopted from Brink et al., 2007)

According to Rinner et al. (2008) the use of Web 2.0 map mashup is still uncommon at planning process, although seems to be a natural way. Table 3 shows the planning theory, Information Technology (IT), GIS and PPGIS developing relations along the last decades.

	Planning theory	*IT*	*GIS*	*PPGIS*
60s	Applied science: IT as resource to a rational, objective planning.	Data and electronic data process.		
70s	Politics: IT as political tools, reinforcing existent power organizations.	Information and management system.		
80s	Communication: information distribution ways with great value.	Knowledge and decision support system.	GISystems	
90s	Reasoning together: IT as tool to enable discussion and communication.	Intelligence.	GIScience	PPGIS
00s	Participatory planning	Collective, social data.	Voluntary GIS	Web PPGIS

Table 3. Planning theory, IT, and GIS (adopted from Klosterman, 2001)

2.2 PPGIS

PPGIS links GIS practices with local knowledge. At this special case, GIS is not for spatial analysis of specific questions, but for production of maps and spatial stories that help to characterize the local space, which supports many planning actions (Elwood, 2006).

PPGIS idea arose from reflections about GIS and society started on the 90s resulting of some arising GIS criticism including value, ethic, and ability to deal with social issues. In 1993 the National Center for Geographic Information and Analysis (NCGIA), promoted a workshop called Geographic Information and Society. This event promoted a series of research questions on a possible bottom-up GIS, and how to incorporate participation into GIS. Later, NCGIA launched PPGIS debate under a new consortium enterprise called Varenius Project. This project was fundamental to PPGIS development and caused a chain of other investigations related to the theme (Craig et al., 2002).

The diverse circumstances and PPGIS methods extend it characterization. Some PPGIS studies show citizens taking part in mapping, others show public using GIS, and still others for decision making. There are also different terms on the literature as Participatory Geographic Information System or Geographic Information Systems for Participation. Certain authors do a distinction based on ranges from users creating the data and not analyzing it, to users analyzing the data but not creating. For Forrester et al. (1999) Geographic Information Systems for Participation is to ease participation and whereby the users are not responsible for the creation or maintenance of the GIS, for example.

Some features justify the growing interest on this emerging GIS field. Maps and images carry information that is understandable by wide audience in an objective way. Map is the best way of organizing spatial information and GIS is the best available tool for interacting with it (Elwood, 2006). PPGIS is also a platform for integrating qualitative and quantitative information that is

usually difficult for researchers to merge (Craig et al., 2002). Recently, the need of transparent decision making because of public responsibility increased the interest in documenting and PPGIS addresses this point with efficacy. Also community participation reverses the GIS tendency of specialized production.

PPGIS is a technological evolution of traditional participation methods. It enables new techniques which are more interactive, possibly empowering communities. However there are limits. GIS data models are suitable for geographic data, but not to represent the more qualitative and perceptual user's entries (Carver, 2001). It raises questions about how researchers can most productively interpret knowledge resulting from different forms of spatial knowledge (Elwood, 2006). Besides, PPGIS applications can empower and marginalize simultaneously since not everybody has access to it (Craig et al., 2002). Finally, the lack of definition and vocabulary tricks the comparison of projects and its evaluation.

2.2.1 Public Participation

Public participation is a consensus building progression with intensive communication and discussion among participants that allows those affected by a decision to contribute into that decision (Tang, 2005). It appeared in the 70's from project presentation meetings with discussion among attendees. But some critics appear based on the ability to engage public enough or to provide useful data for decision making (Forrester et al., 1999). One reason is that often it just told the public about decision already made and asked for comments. In recent times, local Agenda 21 and environment awareness, the Internet with millions of users, and simplified tools for GI use, corroborated to increase the interest on public participation.

Public participation procedure can be split in three parts: information, communication, and participation itself. Public can take part only if there is true, complete and objective information. In the democratic societies the community has the right to get information. However the right does not mean that are obligate to know. The key for a good communication is that each receiver needs a language with the perspective of its own interests. If the information is enough and well communicated, the participation consists in each of the actors give to know his vision, and know the others vision (Centelles, 2006). Table 4 presents a list of communication techniques and computer tools available nowadays.

Variations on the nature of the public and the participation forms impact in the outcomes. Public can be anyone individually interested in a particular issue or organized groups of people with common interests. They are always different in power, culture and wealth. Thus there is no unique public, but types of public based on differing levels of interest (Schlossberg and Shuford, 2005). Schlossberg and Shuford (2005) define public as those affected by a decision or program, who can bring important knowledge, and who have power to influence the implementation.

Participation is the means and purposes for the public to take part in (Schlossberg and Shuford, 2005). It is nonlinear and has temporal and scale units, once public interest have a tendency to increase with the geographical scale.

Action	Forms of communication	One dir.: to public	One dir.: to system	Two direc-tions
Informing	Text or text and graphic attachments.	X		
Educating	Documents with commentaries; Drawing and plan records presented; 3D simulation of planning document; Static images.	X		
	3D interactive simulation of proposed development; Education games and virtual world; Interactive Web sites with 2D graphics or 3D graphics.	X	X	
Capturing citizens opinions	Questionnaires; Survey; Opinions, observations or demands sent by e-mail.		X	
	Observation and recording of actions; Voting.		X	X
Referendum	Mechanisms of decision-making; Voting.		X	X
Transaction	Mechanisms to arrange issues about the participation in planning by Web.	X	X	X
Discussing	Chat room; Message boards, discussion boards.	X	X	X
Cooperating	Virtual public space (users represented as avatars); Data, voice or videoconferencing; Electronic meeting (screen, projector, a few computers); Collaborative management tools: electronic calendars, automatically starts events; Knowledge management: collects, organizes, and manages for sharing different forms of information; Web collaborative software (Wikis) or social software.	X	X	X

Table 4. Communication techniques and computer tools available (adopted from Hanzl, 2007)

Arnstein (1969) participation ladder is a useful analogy for levels of public participation. The base represents zero opportunity to take part in, with successive rungs representing increased levels of participation until total citizen control. Based on it, Carver (2001) proposed the e-participation ladder, where the involvement increases with the access to information. The bottom rung represents online delivery of public services such as payment of rates. Further up, the communication becomes bidirectional making participation more interactive by sharing information and ideas. Alternatively, the Office of the Deputy Prime Minister (ODPM) from U.K proposes five increasing levels (Kingston, and Smith, 2007). Table 5 summarizes these similar models of public participation.

A participatory program might not just intend for outsiders to learn about local conditions. Both experts and nonexperts should be in regular communication (Craig, 1998; Tang, 2005). When developing a public participation project, it is important to (Creighton, 1999):

- Have a clear idea of the expected results
- Involve a wide range of participants and at all the phases
- Promote different ways of participation based on the different levels and public
- Offer real opportunities of decision, through the qualification

- Know to which extend the participation will influence in the decision-making
- Know which are the questions to raise
- Evaluate how much the public interests in the problem
- Clarify what is needed to be learn from the public and what the public need to know to participate effectively
- Identify special circumstances that could affect the program like cultural, ethnic, and political issues.

levels of participation →	Arnstein ladder	ODPM	e-participation		levels of → communication
	Citizen control	Empower: the final decision relies with the public	Decision support system	Two-way	
	Delegated power	Collaborate: partner in each decision and development of choices	Opinion survey		
	Partnership				
	Placation	Involve: public work directly, ensure considering their issues	Discussion		
	Consultation	Consult: get response			
	Informing	Inform: provide public with information	Service delivery	One-way	

Table 5. Public participation models

2.2.2 Social Networks

Social networks are representation forms of human relationships between groups of common interests, which communicate among them. Social networks work mainly in the Internet nowadays because it enables an acceleration and broad divulgation of ideas.

Information technologies always helped people to form social movements. For example, for a longtime printed book were in Latin, mainly with religious subjects, and inaccessible to ordinary people, and the arrival of commercial print media helped ordinary people to think of themselves as part of broader collectivities (Castells, 1983).

The theory of the social networks explain that society has been shifting from hierarchies to networks and this, in great part, bases on the advanced communication technologies. Human being has a huge capacity of collaboratively produce in group. The aspect of public organizing themselves and sharing information and knowledge goes beyond the technological development. It is a cultural and social phenomenon.

For instance, the Wiki born because one software development Website's editor, tired of people asking him to update this or that, invited people to contribute writing informal reports and share these ideas with everybody. To make possible this edition, he created a Web application where anyone could tell his history and could edit what was written improving the content of the information (Jazayeri, 2007). Wikipedia nowadays is between the most accessed Web sites and the use of the tool by the public defined the pattern it has.

Even though, it is still not proved if this emerging informal practices may have an influence on official actions (Brink et al., 2007). As a result the current social networks and trends bring both

optimism and concern. Surely not everybody has access to these tools. But who has, is engaging, and participation is one form of democratic expression. The opportunity to more people to engage is clear. Thus the information is not on few hands. However, as any other communication tool, does not mean the produced is the consensus.

2.3 Web 2.0

Web 2.0 is a move to the Internet as a participation platform with not only information but also services and applications that people can upload as well as download (O'Reilly, 2005). The called second generation of Web services is a trend in the use of the technology that aims to raise creativity, information sharing, and, most notably, collaboration among users (Alexander, 2006). It is creating innovative and easier links between users and computer systems.

The Web is turning more flexible with Web 2.0 tools, from isolated information repositories to interlink computing platforms. The evolving Web 2.0 is creating a revolution in the ways to present, share and analyze spatial data (Hudson-Smith and Crooks, 2008). These collaborative technologies are breaking the barriers between users and developers and making possible to create newer applications through mashups. Without mashup there was no explosion of Web mapping services and thus no increase awareness of GI by public.

Web 2.0 applications typically include social networks services, Web blog publishing tools, Wikis, folksonomies (folks tags to explain and classify content), and mashup. Common mashup applications use Web mapping services to put information on maps, and create new services (for example Platial[7], the one to coin the term Neogeography). Some authors talk about a Web 3.0 already, based on intelligent applications, widespread connectivity, open technologies, and network computing, among others. Table 6 shows a comparison of this Web trends.

Web 1.0	Web 2.0	Web 3.0
10 million users	100 million users	Billons of users
Pushed Web	Two-way Web	Real time Web
Text and graphics	E-mail, audio, video, wikis, blog, social networks	Avatar representation, media flows, and virtual worlds
HTML, XML	AJAX, RSS	Web semantics
Content consumers	Content sharers	Content interoperability
Slow connections	Fast connections	Ubiquitous connection
flash	2D	3D
> 1995	> 2003	> 2008

Table 6. Web 1.0, 2.0 and 3.0 characteristics

Some examples of the first Web 2.0 applications (Jazayeri, 2007):

- Flickr: a photo sharing site where users store their photos and tag them for future retrieval.

[7] Who and what is nearby: http://www.platial.com/

- Social networks (for example MySpace, Facebook): user registers and creates a profile and shares all kinds of information about themselves and interacts with others.
- Blogs (for example Blogger, WordPress): personal Website where the owner does posts that display in a reverse chronological order. Other users can comment on the posts.
- Wikis (for example Wikipedia, WikiMapia): Online communities of people who share interests. It is a content management that creates a repository of information updated easily by its users. The more users there are, the more useful the product becomes.

2.3.1 Web PPGIS

The Web is rapidly becoming the dominant PPGIS platform. The Internet is an extraordinary instrument for creation and free communication which is increasingly occupying an important role in the universe of GI consciousness. More and more appears on the Web ways of sharing knowledge and dividing tasks between people with common interests all around the world. Thus it is an important tool for public participation, both as a source of critical information and for communication (Craig, 1998).

A Web PPGIS is a platform where the user can interact with GI throughout maps by graphic interface online. The number of Web PPGIS exploded in recent years. Primary advantage of Web platforms is that geographic location or time is not restricted, so more people can take part in. The participation is relatively anonymous. And the two-ways flow of information save time and money. It is flexible, can easily be update with more relevant information. People can enter their opinions as much as they want. Also, extra features like videos or 3D animation bring familiarity (Kingston et al., 2000).

Web PPGIS fundament is the interoperability between GIS and Internet tools on a participatory environment. In other words, GI data and GIS tools available on Internet to public engage. Web 2.0 tools have the solution to the participation needs like discussion forums and maps customization. On the other hand, the GIS tools usually available are simple ones, as zoom and pan, topological overlay, information retrieval, query, data selection, and distance measure (Steinmann et al., 2004).

Internet access can be a barrier for Web PPGIS, especially in developing countries. But the called digital divide is rapidly being overcome. Figures 4 and 5 show the numbers of Internet user's worldwide for 2002 and 2008. The change in developing countries stands out. However there is exclusion also about culture, education, and ability to understand all that is happening on the Web (Castells, 2001). This only may be overcome with education. People need training to deal with GI to transform their participation in real decision making.

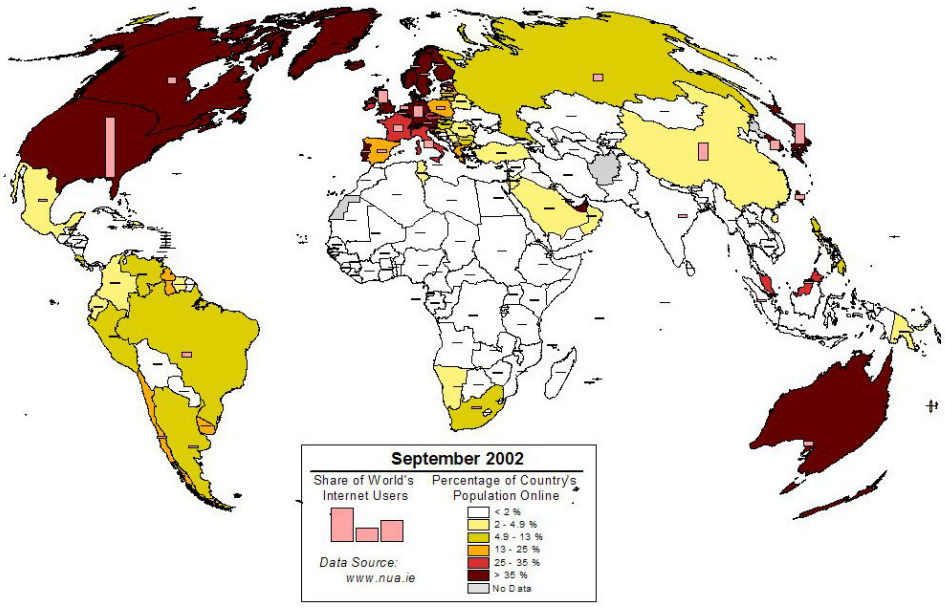


Figure 4. Internet users worldwide 2002 (http://www.zooknic.com/Users/index.HTML)

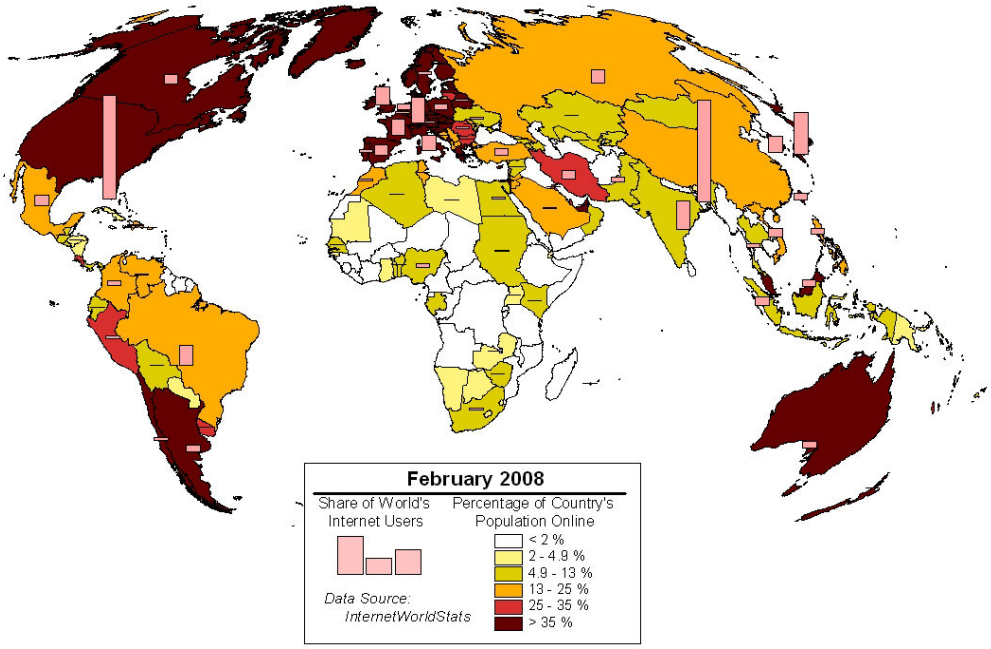


Figure 5. Internet users worldwide 2008 (http://www.zooknic.com/Users/index.HTML)

2.3.2 Web Mashup Applications

Web application is an application accessed by the browser over the Internet, running regardless the operational system. The ability to update and maintain it without delivering and installing

software is central (Jazayeri, 2007). Web applications have the characteristic of services accessible by users and by other application throughout mashup. Mashups are Web applications that combine resources from remote information sources and other applications to produce something new that meet specific user needs.

Web mashup applications are promising to become pattern within next year's. But to create something using this technique is not as simple as may sounds. However, it is much easier than developing everything from scratch. Open API provides the functionalities, as a list of procedures and functions.

On a standard Web application environment, Web browser is the user interface that interacts with the user, manages the data stored on the servers, and returns the clients requests. The client (Web browser) contains the WebPages and forms that user navigates on the application and interacts with the data. The server consist of the responses on the Web browser for the users actions, on the transfer and transfer requests from other Web applications, and on the database. To keep the browser-sever relation, the server returns a Webpage to the browser (Figure 6) (Jazayeri, 2007).

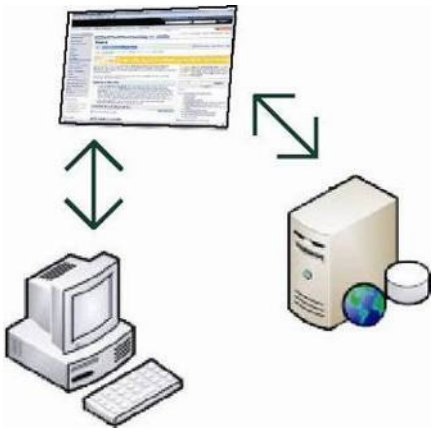


Figure 6. Web application diagram

Since Web applications started to allow more actions, the applications become more complex, and the communications between the Web application environment parts more problematic. This leaded to the development of script languages where the code is executed by the browser (for example JavaScript) or by the server (for example PHP). Client-side scripts run on the client and interact with the user. And server side scripts perform processing on the server and typically interact with databases. Client-side scripts, embedded in HTML pages, refer to user-interface entities such as windows and menus. They also react to user events like mouse movements and clicks. Server-side scripts deal with other types of objects such as clients and files (Jazayeri, 2007). Table 7 presents some evolving technologies description and its benefits.

Technology	Description	Benefits
XML: Extensible Markup Language	Set of Web data rules developed by Worldwide Web Consortium (W3C) to suppress HTML limits.	Descript and stores data as a database. Universal format, understandable by humans. Allows transparent exchange among different platforms.
JavaScript	Script language which supports sophisticated client-side processing by the browser.	Allows the client to perform many of the roles done by the server. Provides a high degree of interactivity to the application.
AJAX: *Asynchronous JavaScript and XML*	JavaScript and XML to make the browser more interactive through asynchronous information requests.	The Web application can run in the client browser. The practice at server is lower. Avoid the refresh need.
RSS	Web feed format based on XML language.	Can merge different RSS feeds to produce sites with richer content. The information goes to users, not users to information.
PHP: Hypertext Preprocessor	Server-side HTML embedded scripting language, object-oriented.	Open source and multiplatform. Dynamism on the server side processing.
SQL: Structured Query Language	Standard database computer language.	Many database products support SQL like PHP languages or MySQL database.

Table 7. Evolving Web technologies

3 WEB 2.0 PPGIS IN PRACTICE

Presented Web PPGIS projects vary on participatory level, from simple geovisualization portals to more complex decision support systems. But commonly, they do not focus on the particular needs of participatory planning, as discussed on the previous chapters. One barrier is there are no GIS able to handle topology by relations, often necessary on planning studies. Sieber (2004) explains that PPGIS projects should not try to move public participation into GIS but to organize and present relevant information that was not previously available, using the technical capacity of GIS. GIS maps for participatory planning are seeing more as cartographic texts, part of an interpretive production of meaning (Elwood, 2006).

Developing Internet has led to evolving Web PPGIS techniques which enable users to query maps and to create their own customized map, namely Neogeography and Voluntary GIS ideas. However the objective on participatory planning is to use maps for user's identification of the points of interest based on different types of data that links user mental maps and system map. For example, one knows he or she lives close to school "x" so when identifying it, the geographical area becomes familiar. Besides, use maps to add personal content geographically, as notes, or other media like photos and videos. And in turn, see the data created by other users to provoke communication based on the geographical location.

This chapter presents first a fast but broad review on related work that inspired the present project. Following it introduces the functionalities and technologies that configure the present Web 2.0 PPGIS and describes the development steps. Finally it presents the performed version.

3.1 Related Work

Selecting the related work was based on the literature review, currently online examples, and on the use of Web mapping services, as the present proposal does. Table 8 presents a comparison of the applications discussed next and the respective tool it applies.

SOS Mata Atlântica[8] and London Profiler[9] are examples of geovisualization portals that deliver GI online. The first displays spatial data about Brazilian Atlantic Forest (*Mata Atlântica*) protection. It makes use of a well-known open source program: MapServer, which follows Open Geospatial Consortium standards (OCG) (Figure 7). While the second, pictures London neighborhood's spatial data through GMaps services and GMapCreator from CASA (Center for Advanced Spatial Analysis - University College London). Both allows users to select the wished data layer by distinct classes, but do not support any form of opinion sharing among users or even from the users to the system. On the London Profile, additionally users can select areas by postal code or to overlay a KML URL (Figure 8).

[8] http://mapas.sosma.org.br/
[9] http://www.londonprofiler.org/

Tool	Pro	Cons	Application
Geovisualization	Make spatial data available.	Do not support opinion sharing.	SOS Mata Atlântica and London Profiler
E-mail feedback	Allows opinion sharing.	E-mail can be ambiguous and do not enable exchange of spatial data.	Map Hackney
E-mail plus map with sketches.	Transfer spatial content.	Do not support transparent exchange of comments: other users don't see.	Orange County Interactive Mapping
Georeferenced comments	Clear comment geographical location.	Comments are not organized or related to each other. No idea on the evolution.	Virtual Slaithewaite
Online forum + georeferenced comments	Transparent exchange of comments.	Map as user interface to the comments, when is not organizing it.	Argumentation Map and GeoDF
Collaborative	Allows user input and two-way flow of information.	Data trust and accuracy.	WikiMapia and WikiCrimes

Table 8. Tool's comparison (adopted from Steinmann et al., 2004 and Tang. 2005)

Figure 7. SOS Mata Atlântica interface (http://mapas.sosma.org.br/)

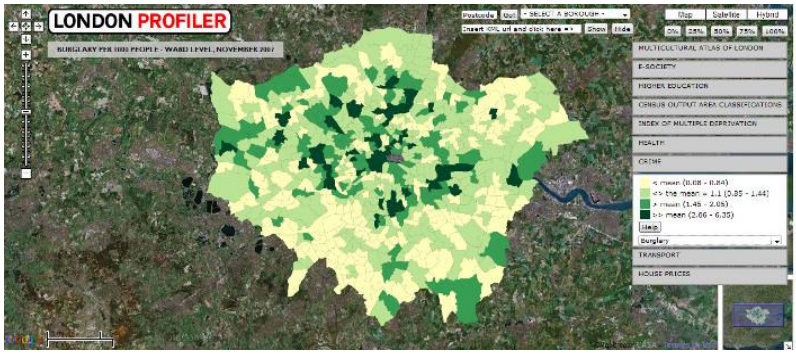


Figure 8. London Profile interface (http://www.londonprofiler.org/)

Map Hackney[10], a Londoner borough, displays various maps by topics, with some basic capacities, as panning and zooming. It use e-mail as a means to enable public to provide opinion, but it do not implies on a map-based discussion (Figure 9). Orange County Interactive

[10] http://www.map.hackney.gov.uk/framesetup.asp

Mapping[11], from the city of Orlando – Florida, has improved it by allowing participants to attach a map to the e-mail message. Besides, users can sketch and comment on the map (Figure 10). Both of these examples primitively allow two-way flow of information.

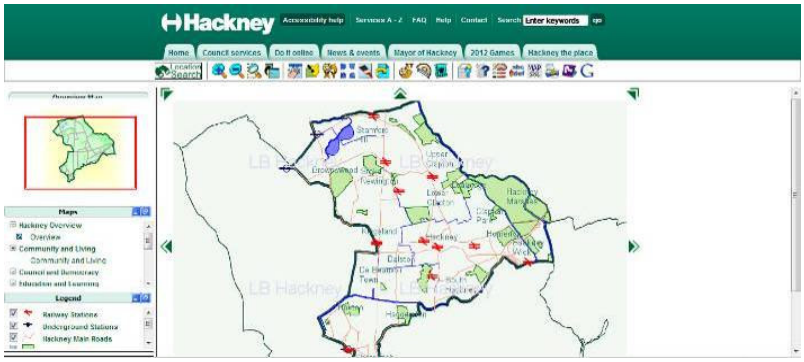


Figure 9. Map Hackney (http://www.map.hackney.gov.uk/framesetup.asp)

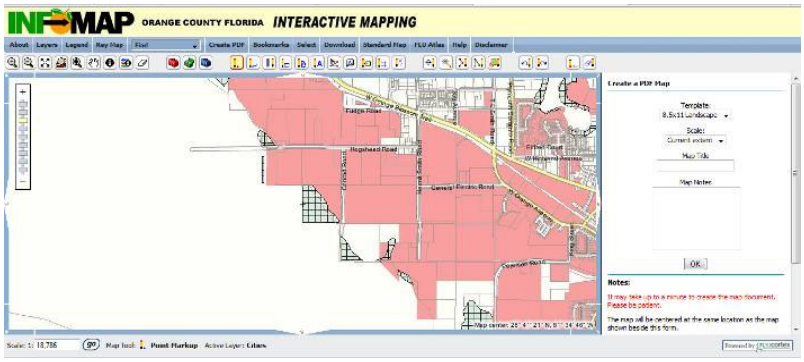


Figure 10. Orange County Interactive Mapping (http://ocgis1.ocfl.net/imf/imf.jsp?site=orangecFL)

Virtual Slaithewaite[12] (Kingston et al., 2000), project by the School of Geography - University of Leeds, use the Web for the participatory planning of Slaithwaite – UK. The village online map allows citizens to zoom and pan, to select features, to get information about features, and to add their comments or suggestions. Users could also perform simple spatial query. All user input is stored at a community database for future analysis.

It makes use of GeoTools Java map application library. A text box on the left of the screen contains instructions and help information, and a big map is displayed on the center-right (Figure 11). When selecting a feature a text message displays what it is and the original text box changes to receive users text commenting. Any features selected provide a free-form typing text box. Once user finish they send the comment and a series of questions appears on how users felt using it.

[11] http://ocgis1.ocfl.net/imf/imf.jsp?site=orangecFL
[12] http://www.ccg.leeds.ac.uk/projects/slaithwaite/ppgis.html

Authors see the profile as an essential part once it could be used to build up a database of users to help confirm responses and analyze user's behaviors. According to them, the instantaneously update of the database is one of the great advantages over the traditional technique. However it does not allow users to view other people's comments. This, on the authors view, avoids public to do suggestions in response to seeing a cluster of flags on the model where many other people have made the same or similar comments.

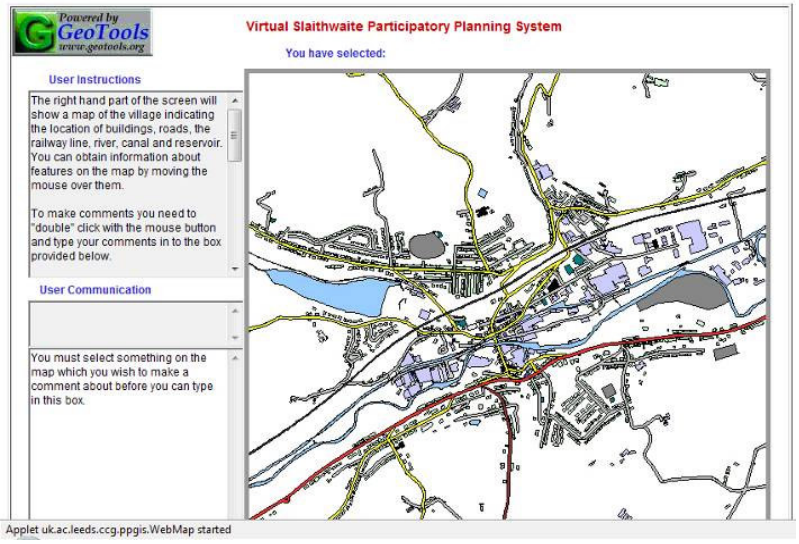


Figure 11. Virtual Slaithewaite (http://www.ccg.leeds.ac.uk/projects/slaithwaite/ppgis.html)

Argumentation Map prototype (Keßler et al., 2005) developed solutions for georeferencing comments and following discussions. It makes geographic references in discussion and uses them for linking text messages to maps on a Web-based application. It allows analysis, for example, looking for the most controversial objects on a map. Contributions can be accessed by selecting the matching reference objects on the map. Labeling allows users to mark their contributions. Icons show contributions by type, next to its title in the discussion tree (Figure 12).

The discussion unit resembles a newsreader integrated into a client-side Java Applet. The map unit relies on the GeoTools libraries. The server-side unit allows the client to recover maps from Warehouse Management Systems (WMS) and the database, to load the discussion contributions and their geographic reference objects, and to insert new datasets into the database (Keßler et al., 2005). Authors say that further basic security mechanisms such as user identification and a secure setup of the database are needed to impede a manipulation of the discussion.

GeoDF prototype (Tang, 2005) is similar to Argumentation Map. However, GeoDF prototype tries to improve communication by integrating an online discussion forum. The spatial content of each discussion contribution is stored and displayed with the text message with a map view. Thus it organizes communication messages more effectively, according to the authors.

Participants can express their views not only with text messages, but also make sketches and notes on the GIS map. The contributions are organized and presented in such a way to make easy to understand evolving ideas throughout the discussion (Figure 13). The online discussion forum is at the bottom. It documents evolving ideas and decisions, supporting the transparent exchange of opinions among the participants.

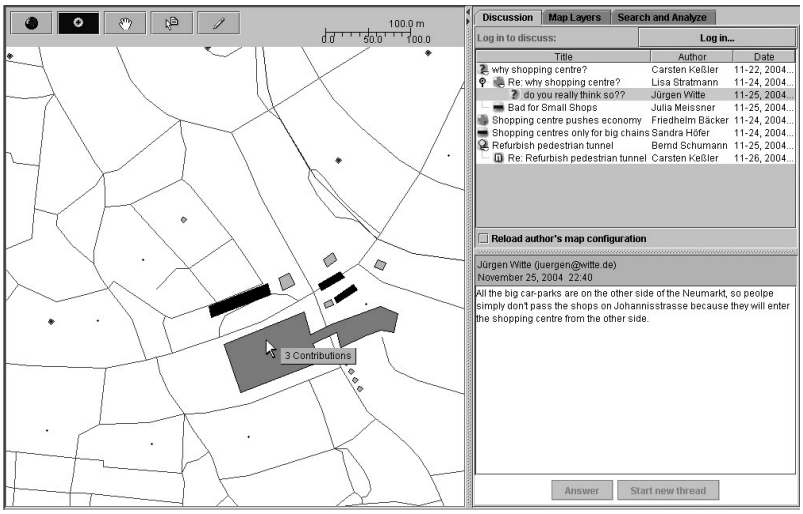


Figure 12. Argumentation Map prototype (Keßler et al., 2005)

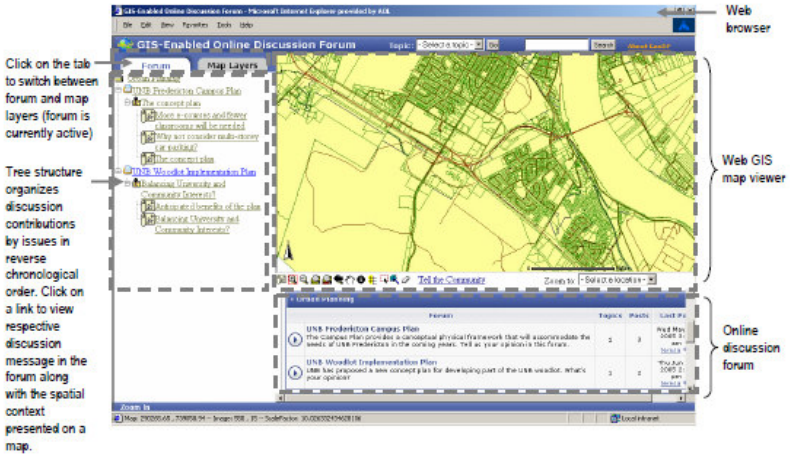


Figure 13. GeoDF interface (Tang, 2005)

WikiMapia (WikiMapia, 2009) is an online application that combines Google Maps and Wiki, launched on May 2006. It aims describing the whole world with folk's knowledge. It has already more than 8.5 million places marked (October 2008). Any user can add a placemark to any location by marking out a polygon around the location and then providing a default language, title, description and category. The features appear in different colors depending on the category of the tag. Images, videos and links to other pages can also appear on the place's

information window. Registration is not compulsory to edit or add. But just registered users can check certain areas, showing edits and additions to the map, and send personal messages to one another. Basic tools for measuring distance and land area, and for mapping IP addresses to locations, are available also. Besides, users can vote in favor of or against other users' contributions as a means of data trust (Figure 14).

WikiCrimes (WikiCrimes, 2009) is another typical example of Web 2.0 application using Google Maps service, produced at the University of Fortaleza, Brazil. It lets users to search, view and post criminal events on the map. After registering, users can select crimes by category, place a marker at the location, and fill out the crime information. The Webpage automatically displays statistics on the contributions. As a Wiki project, it is based on the principle that individual participation can produce wisdom for the masses. The concern was that victims of the crimes usually do not report the events or the police monopolize the information and the facts. Therefore, according to the creator belief, with the information placed by the users collaboratively, it becomes an efficient tool against criminality (Figure 15).

Figure 14. WikiMapia showing a selected feature information window (WikiMapia, 2009)

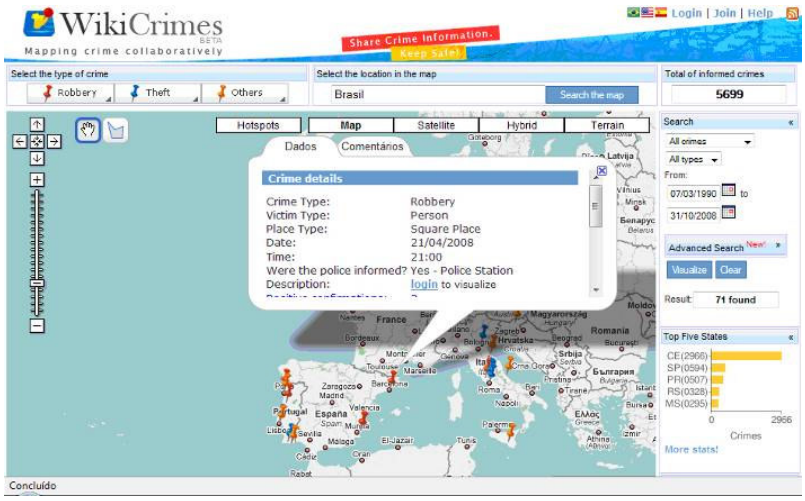


Figure 15. WikiCrimes (WikiCrimes, 2009)

3.2 Functional Requirements

To develop the proposed Web PPGIS platform, we divided the work into 4 steps (Figure 16): 1) Visualize map and layers; 2) Edit and add comments; 3) Save and send comments; 4) Database.

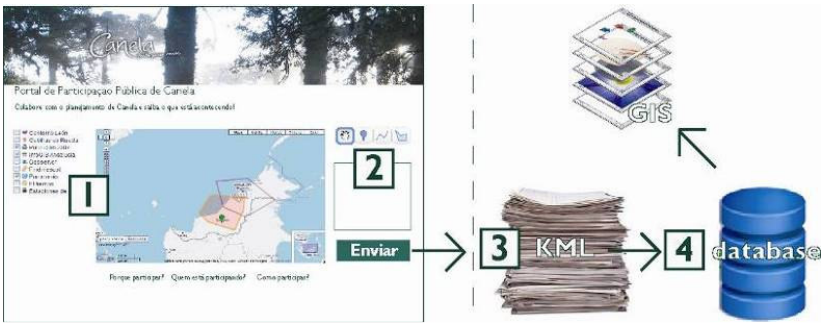


Figure 16. Web PPGIS development diagram

1) Visualize map and layers

Consist of adding the custom GMaps interface to the Website (Figure 17), which includes:

- Maps controls: drags the map by mouse movement or clicking the arrows placed on the top left corner
- Zoom control: let zoom in and out of the map
- Map type control: present types of base data (map, satellite, and hybrid)
- Overview map control: place the map view at a larger geographical context.

As many other applications, GMaps display KML files[13], which is a format widely applied to display geographic data on the Web. At the home page (Figure 18), beside the mapping service, eligible GI layers display the spatial data. It should display, for example: land use, neighborhoods borders, census data, master plan use zones, urban equipments and natural resources.

2) Edit and add comments

Setting the editing tool will allow users enter their opinion by selecting a marker icon and when placing the marker on the map, an info window opens and the user does a text message comment on this geographic location. The markers colors match to 5 planning topics: community equipments, economy and tourism, infrastructure and services, habitation, and urban planning. Organizing user's comments by topics and colors mirrors the role of the physical public participation meetings, which use, for example, colorful post-it to public commenting on paper maps.

3) Save and send comments

The user contributions are stored into the database. It allows further consulting entries by geographical location (x and y coordinates) for spatial analysis. For instance, a cluster on a topic

[13] Few examples: Google Earth, ArcGIS, PhotoShop, AutoCAD, Flickr, Yahoo! Pipes, Open Layers, Microsoft Virtual Earth, and Google Mobile.

may show a pattern. The comments are saved with the context: coordinates, zoom level, active layers and so on. In this way the expert can see the comment and all the map settings the user was seeing at the moment of the entry. This allows a better understanding of the "user emotion".

4) Database

This step consists in building the database and setting the connection with the application. The database stores all the users' entries. Registration is needed since one user can do as many comments as he or she wants, but all the comments have to belong to a specific topic. As mentioned, each user entry consists of text message, geographic coordinate of the point, active layers, and zoom level. Thus, technicians can use the created content for spatial analysis by querying user's entries by date, topic, geographic location, satisfaction, and so on.

Besides, other pages may complete the Web application:

- Extra information: display graphics, reports, sketches, 3D models, and static maps
- Help: necessary information to help the use, such as step-by-step orientation or getting started info
- Contact: information about the platform objectives and the contact person

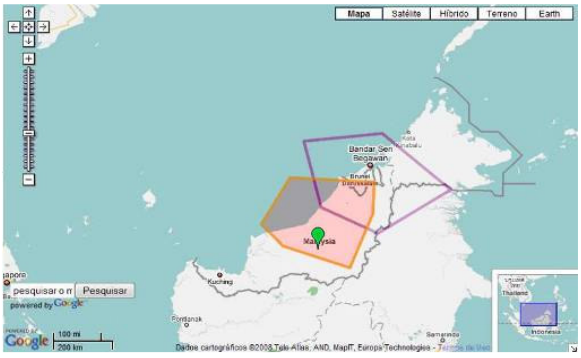


Figure 17. Custom GMaps interface. Maps and zoom control on top left corner. Map type control on top right corner. Scale control on bottom left. Overview map control on bottom right.

Figure 18. Home page early ideas: layers on the left side, mapping service on the center, and editing and commenting tools on the right.

3.3 Technology Requirements

Various technologies are available to set up the proposed Web application. Following, we discuss only the ones enabling this specific prototype version, which attend to three conditions: supports rapid development, is easy to learn, and is free or open source.

- *Mapping viewers*

Map viewers are essential in GIS applications to allow user to visualize and inspect the geospatial data and layers over a map. Google Maps is probable one of most known mapping services because it is programmatically accessed by an easy-to-use and free API, breaking many barriers to access GI on Web (Pimpler, 2007).

Google Maps API (Google, 2009) is a library of JavaScript files so developers normally build Web pages with Google Maps API using JavaScript. Google Maps API is compatible with most browsers. However it is important to pay attention to browsers compatibility with all code pieces because built-in JavaScript engines are slightly different in each browser. Besides, the client receives millions of images to compose the maps. So a relatively good connection is necessary.

Google Maps API is at Beta version, what implies that may contain errors and suffer changes in the future. It is in continuous and fast evolution, what causes constant changes, either to correct errors, or to add new functionalities. But while the following version is compatible, the API update automatically. According to the terms of service, the source code and the data service have copyright, thus the service cannot be used to develop other commercial services. Currently the service does not include publicity, but Google reserves the right to do it (Google, 2009). Alternatives to GMaps are OpenLayers and OpenStreetMap, although with smaller potential of development.

- *Scripting languages*

Scripting languages are closely related to the programmable Web[14] because they allow for instance to glue spread Web services with Web client applications like browsers. There exist multiple scripting languages that are mainly clustered into two categories: client-side and server-side scripting languages. This project used both types of scripting languages.

On one side, JavaScript is a well-known client-side programming language supported by most Web browsers. It supports sophisticated processing on the browser. Thus the client can perform many of the roles done previously only by the server, providing a higher degree of interactivity to the application. Within the typical actions that JavaScript carries are the pages active contents (for example movement, or color change), and the interactive answers to the user's actions. In particular, the GMaps API makes use of JavaScript.

[14] ProgrammableWeb - Mashups, APIs, and the Web as Platform: http://www.programmableWeb.com/

JavaScript is simple enough to develop quickly. Anyone that does not have a prior experience in programming is able to learn the language easily and use it with little practice (W3Schools, 2009). To program in JavaScript one only needs a text editor and a browser compatible with the language. Besides, HTML pages usually embed JavaScript codes.

On the other side, PHP (that stands for Hypertext Preprocessor) is a server-side scripting language that implies significant interactivity and dynamism. It is another popular open source language, with good support and easily learnable. PHP is compatible with almost all servers used (for example Apache or IIS), supports most databases (for example MySQL, Oracle, PostGIS, PostgreSQL), and runs on different platforms (for example Windows, Linux). The processing result is an HTML document which is displayed by the browser (W3Schools, 2009).

- *Semi-structured languages*

In client-server architectures there is a need to interchange information among remote, scattered hosts. Clients send requests to servers that replies with responses. Requests and responses are essentially pieces of data that must be codified in a certain way. XML is general and extensible enough to become the standard language for data exchange on the Web. In addition, it serves as a meta-language, that is, it is the basic syntactic language on which other domain-specific description languages can be built.

Within the latter category we find KML (Keyhole Markup Language), an XML-based language for geographic content, first created to display data on the Google Earth platform. It specifies a set of features to any location which always has a longitude and latitude. It allows developers to define tags, giving meanings. This turns the document more intelligent. Since April 2008 KML 2.2 is an Open Geospatial Consortium (OGC) standard. GMaps supports many KML elements: placemark, icons, folders, polylines and polygons, styles for polylines and polygons, and so on. However it has limits about the sizes of files, the number of features, and the number of vertices in polygons and polylines (Google, 2009).

- *Database Management System*

MySQL is a popular open source database management system, easy to set up that runs on several platforms. It is suitable for simple application such as the present prototype where we have, at this version, just points. If we had polygons and polylines, PostgreSQL + PostGIS would be the obvious solution since they support complex spatial databases and geospatial data.

- *Apache Web Server*

On Web Server field, the Apache Web Server is a widespread, well-known free HTTP server and thus used in this project.

3.4 Architecture and Components

A Web application runs partly in the Web browser client and partly in a dynamic Web server. At the client side, the user views HTML documents and interact with them, usually by mouse clicking over its active elements. The JavaScript code running on the backside of client's browser can handle these user events and fire actions. It communicates with the server to post or retrieve new chunks of data, or changing the document's structure and its appearance.

The server side can deliver static information, such as HTML documents and images, or dynamic data, usually produced by the server's code from the database contents. The data can be created at any suitable format, as HTML, JSON or KML. Web browsers can also send data from users to the server. The sent data will be parsed and usually inserted into the database. Appendix I includes more implementation details (code, concrete scripting functions, etc.) of the Web 2.0 PPGIS application.

At the client's side, a browser includes some JavaScript functions (see Appendix I) that manage user events, requests to the server, and adjusts HTML documents based on the server responses. To see spatial data, we have embedded in the browser a mapping viewer using the Google Maps API. Some JavaScript snippets have been developed (see Appendix I) based on Google Maps API, which allows loading spatial data from KML files returned by the Data Transform component at the server side.

At the server side, we find Web services as showed in Figure 19. These Web services are grouped according to the action they perform.

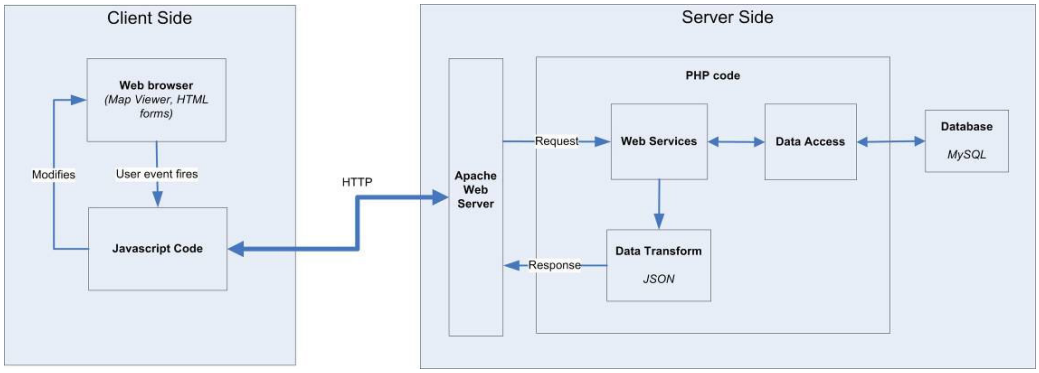


Figure 19. Web 2.0 PPGIS architecture

Web services receive client requests, and delegate the control to other services (data access and data transform services) depending on the user action. When a user ticks a specific spatial layer to be visualized, this triggers an event to perform a client query to Web services. These services manage user requests and delegate the user action in this case on data access services to retrieve the data layer demanded by the user.

Data access services provide an abstraction layer to access to the underlying database records. In case of database requirements were changed, we would only have to adapt the code of the Data access services. The reaming service, both at server- and client-side, would keep invariable.

Data transform services are in charge of transforming data retrieved from the database into a suitable encoding ready to be consumed by client components. JSON format has been the choice of encoding in this project because fits nicely with JavaScript language, that is, data encoded in JSON ca ne directly processed using the JavaScript built-in function eval().

The database stores can be the user created data. Users create data selecting a topic, adding a point at a geographic location on the map, writing a text and labeling it. So, to better transfer a participant's perspective, the comments are stored with the active layers, map zoom level, message label, referring planning topic, geographic coordinates (x and y), and date of entry. Users need to register to be able to send comments. To register, each user needs to provide a user name, password, e-mail, neighborhood, sex, age and profession. This is important to further analyze statically participation and avoid problems of trust and reputation. One user can do as many comments as wanted. Figure 20 shows the database schema and its relations.

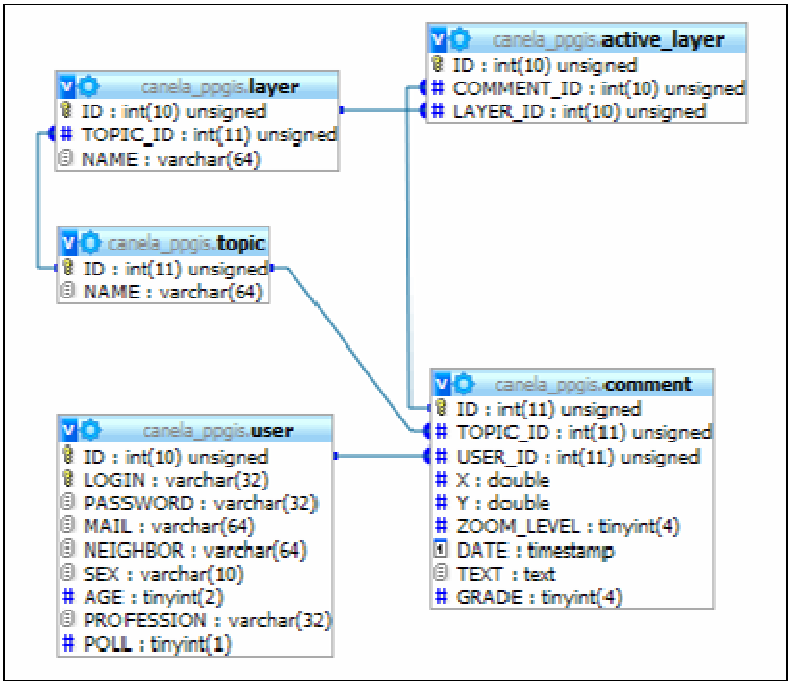


Figure 20. Database schema

To create the KML files, first it was necessary to transform the reference system from South American Datum 1969 (SAD 69), used in Brazil, to World Geographic System 1984 (WGS 84), used in GMaps. To improve the readability of the data, preprocessing, such as simplifying details,

reclassifying, and classifications was also necessary. Shp2kml[15] tool created the KML files from ESRI shape file. It is free and supports, among other features, point, line and polygons, labeling from attribute table and info window creation. Table 9 shows the list of KML files created, its feature and respective participation topic. These topics organize the data by urban classes mirroring the method often used with paper maps. The icon represents a comment.

	Name	Feature	PP topic	Icon
1	Education	point	Community equipments	
2	Health	point	Community equipments	
3	Security	point	Community equipments	
4	Parks	point	Community equipments	
5	Culture and sports	point	Community equipments	
6	Natural resources	point	Economy and tourism	
7	Tourist spots	point	Economy and tourism	
8	Hotels	point	Economy and tourism	
9	Commerce	point	Economy and tourism	
10	Industry	point	Economy and tourism	
11	Water supply by census track	polygon	Infrastructure and services	
12	Sewer by census track	polygon	Infrastructure and services	
13	Garbage	line	Infrastructure and services	
14	Public transport	line	Infrastructure and services	
15	Pavement	line	Infrastructure and services	
16	Neighbors	polygon	Urban planning	
17	Urban growth	polygon	Urban planning	
18	Land use	polygon	Urban planning	
19	Master plan use zones	polygon	Urban planning	
20	Irregular settlements	polygon	Urban planning	
21	Social habitation plan	polygon	Habitation	
22	Projects	point	Habitation	
23	Census track inhabitant characteristics	polygon	Habitation	
24	Census track occupation characteristics	polygon	Habitation	
25	Census track habitat characteristics	polygon	Habitation	

Table 9. KML files

3.5 Implemented Version

At this version, users interact with the system sending the comments and seeing others comments. The visualization methods are the GI layers and the mapping service. The functionalities set up are (Figures 21 to 25):

- Turn on and off layers of spatial planning issues organized by topics
- Click on the layer features (points, polygons or lines) to access GI and attributes
- Place a point in the map and make a text comment labeling it
- Send comment to system
- See all the comments made by others
- Download extra information as static data (PDF).

[15] http://www.zonums.com/shp2kml.HTML

Users have to register at the login page to be able to send the text comment. Likewise, other two pages complete the platform, a help page and an extra information page where static documents can be put available for users to download.

Figure 21. Point information - education

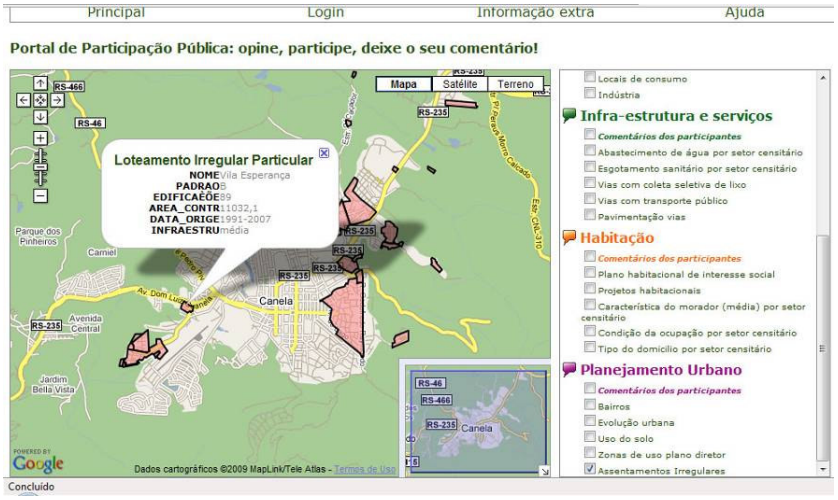


Figure 22. Polygon information - irregular settlements

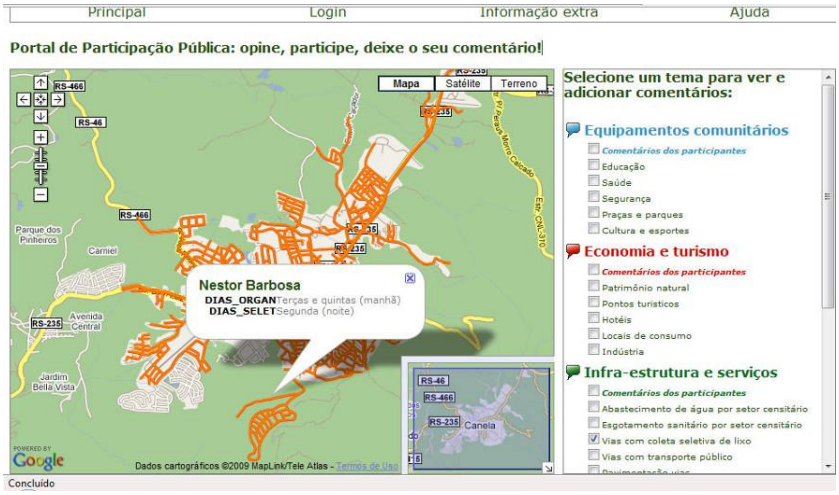


Figure 23. Line information - garbage selection

Figure 24. Text comment window

Figure 25. Viewing user's comment

4 EVALUATION WORKSHOP

To evaluate the Web 2.0 PPGIS the city of Canela (see 1.4 Case study) received a workshop from 12 to 15 January 2009 at the City Hall. Users tested the Web 2.0 PPGIS as prove of concept. The primary goal was to evaluate whether the technology could strengthen participation and second, note how easily the public use it and to each extend they accept it.

4.1 Evaluation Criteria

Overall, PPGIS studies stress more the technological parts than evaluating if the tools are usable (Craig et al., 2002; Steinmann et al., 2004; Zhao and Coleman, 2007). Although, recently authors are approaching this topic on studies connecting PPGIS, usability tests, and Human-computer Interaction (HCI) discipline, which concerns with the design, evaluation and implementation of interactive computing systems.

Usability tests are usual in software development with the aim of systematically address the user and use perspectives. Usability testing with real users involves watching target users or existing users of a system interacting with it by performing a set of real or representative tasks. It aims to evaluate whether it works and has met its design goals. In this approach usability evaluation is central to ensuring if the design meets user needs (Haklay and Tobon, 2003).

Steinmman et al. (2004) conducted a qualitative expert analysis evaluating twelve PPGIS applications according to their usability, interactivity and visualization, and made comparisons between the US and Europe. Sidlar and Rinner (2007) employed a quasi-naturalistic[16] case study and focused on the general usability of the Argumentation Map (see 3.1. Related work). Zhao and Coleman (2007) developed a list of evaluation criteria because they believe that, without empirical evidence, it is hard to tell whether the advances in technologies will benefit and empower the public. Also Haklay and Tobon (2003) explain from three workshops how usability evaluation may contribute to PPGIS research.

The criteria chosen for evaluating the usability of the Web 2.0 PPGIS is a combination of developed methods at previous PPGIS usability studies (Haklay and Tobon 2003; Steinmann et al., 2004; Zhao and Coleman, 2007; Sidlar and Rinner, 2007). We assume that, even using basic criteria, the results would show if the application is successful in meeting its goals. Below each one is described:

a. Cost of entry: includes the price of the prototype, the tools needed to run it or access it, as well as the time it takes to set it up.

[16] Quasi-naturalistic studies use a real-world context but with such controls that both evaluation and collecting of information are easier and therefore a deeper investigation can be achieved than naturalistic studies (Sidlar and Rinner, 2007).

b. Intended users: background of the different users. Includes features such as the experience in using similar software and educational level.

c. Ease of use: if users find the application easy enough. Reflected in the levels of speed, completeness and correctness in the test performance.

d. Satisfaction: degree of emotion the users credit to the contact with the prototype. Reflected in the positive attitude or opinion reported.

e. Usefulness: if the application achieves the goals of participatory planning. The equilibrium between sophisticated roles and simplicity of use.

f. Efficiency: ability to fulfill its roles and objectives while taking a slight amount of resources.

4.2 Evaluation Test

Potential users received e-mail invitations to take part in the workshop: a list with 30 voluntaries from the public participation meetings of the Social Housing Plan and other from associations, journals, politicians and commercials. The Canela community at Orkut (social network) also received an invitation. In addition, as the experiment took place at the City Hall, it attracted curious transients to see what was going on.

The test was individual; one computer with Internet access was available with the Web page already open. One person with urban planning and GIS backgrounds conducted the test, both as facilitator and as observer. There were neither video nor sound recorded to make it more natural to participants. Nevertheless they were encouraged to think aloud while using the Web application.

Even though Canela had just finished developing the Social Housing Plan, we decided not to focus on any specific planning question. Instead to leave it opens to all spatial comments. The platform itself encourages topics related to planning topics, as they organize the GI layers. Without a clear definition of what information participants should report, we expected them discuss planning issues they concerned for real.

The experiment consisted of a short introductory section, a practical section and a questionnaire. At the introduction the facilitator briefly explained the objectives of the test, the main interface and its functionalities. When voluntaries were ready to start, the facilitator encouraged them to put hands-on it. The test task was to send at least one comment. At this practical section time spent was counted down. While users perform the task, the observer took notes on major pitfalls, expressions, difficulties, satisfaction and humor showed. Only when asked to, the observer did help or provide hints. They could perform the test for as long as they wanted to.

After users said done with the practical section, they answered a questionnaire with 7 direct questions (Table 10) and 4 free answering questions (Table 11). The direct questions considered topics related to the prototype usefulness, easy of use and satisfaction. The free answering questions serve mainly to analyze the prototype functionalities and tools considering a real implementation.

Besides, at the beginning, participants were asked about their use of Internet and familiarity with GIS. As well, at the registration page of the Web 2.0 PPGIS, users had to fill out gender, age, and profession to login. The objective here was to identify the participant characteristics and ability to understand the system.

Do you agree with these affirmations? ( ) yes ( ) no ( ) more or less
1. I found the platform easy to use and understand
2. I found the information interesting and important
3. I would like to use this platform frequently to give my opinion
4. I think this platform can enhance public participation in decision making
5. I think all municipalities should have a platform like this available for the community
6. I think that people in general would like to use a platform like this
7. I think that people in general would be able to easily use a platform like this

Table 10. Direct questions

Answer:
8. What do you think is missing?
9. What do you think could be improved?
10. Do you think this platform could be useful for Canela? For what?
11. What did you like more and what did not?

Table 11. Free answering questions

4.3 Results

In total 22 voluntaries took part in the test, 11 male and 11 female, with an average age of 41.3 years old, being 58 the maximum, and 24 the minimum age of participants (Figure 26). They posted 41 comments in total. The average number of comments by user was 1.38, median 1, and maximum 11. The average time users spent interacting with the Web 2.0 PPGIS was 14.28 minutes, median 13, minimum 5, and maximum 31 minutes. By the differences in maximum and minimum number of comments and time spent is visible the diversity in user's interest and ability.

Figure 26. Stakeholder testing the system

About the participatory planning purpose, all topics received comments. The comments in general are useful and relevant for planning issues. Table 12 looks at some of the observations. Most of the users classified the comments as suggestion, with 28 labels, while 9 were labeled as complain and 4 as in favor of.

Planning topic		Example
Community equipments	8	This neighborhood needs urgently a leisure area; children are playing on the streets. Improve the main square infrastructure use; the fountains are not active, for example.
Economy and tourism	14	Improvement of the access to the Morros Pelado, Queimado and Dedão parks. Localization of the future International Airport of Canela, in process of environmental license.
Habitation	2	I believe this construction should be in another area; having minded the number of water sources that exists there, it is necessary to preserve those nascent.
Infrastructure and services	13	Repair of the floor of all the Paul Harrys Street. Public transport should have more time alternative to the main bus station. Here is a small shopping center, with a paving of the walk in bad conditions; it is a risk for pedestrian. Trash collection does not attend Santo Antönio Street. Improve bus lines distribution to attend also other town areas as Vila Suzana. Set up free Internet wireless service for the whole urban area.
Urban planning	4	The streets without paving of the Palace Hotel Neighborhood need maintenance urgently. Green area in the Santa Marta Neighborhood's invasion should be solved and the lands already invaded legalized for those inhabitants begin to pay property tax like others that contribute to the town.

Table 12. Participant's comments

Looking first at the observer notes, what is immediately interesting is that not all users navigate on the map panning or zooming. For instance, the zoom level 13 is the default and was the mode used by participants to send comments. Fewer users explore till the minimum zoom level, while the maximum was largely used, because they need greater levels of detail to identify places of interest. The majority that did navigate took some time on finding the local of interest. Street names said to be useful, but many expressed they would like to see place's pictures.

None of them checked all the GI layers, but many did check other's comments layer. It is important to consider simplicity need, though many users asked to add more information on the layer's list. Considering other operations, one user asked to measure distances.

Once more, several users just placed a comment at an arbitrary place, did not explored the mapping service or layers. This implies consideration on how to interpret, classify and store comments when they do not have a specific geographic location. The system does impose that a geographic location needs to be selected to entry a text message.

Delving into a more detailed analysis, problems with the interface and system design include lack of feedback telling if something was happening after issuing a command. Particularly when selecting the icon to add comment. The mouse icon should change to the selected icon to make sure users know they selected it. Also there is lack of visual guidelines to point out how to manage the Web 2.0 PPGIS. Another one is the general lack of visual representation of current page or status. For example, when at the main page, it must be reinforced visually on the menu.

Another example is that some layers take time to draw. Users do not know when finished and click on the map, crashing it. Here again a visual communicate would be useful to guide users to wait while the command is been processed. Also annoying pitfalls that can be easily solved include text comment window cut when out of the mapping service boundary (Figure 27); icons that do not disappear with the next command (Figure 28); and layers overlap making impossible to reach the information on the back (Figure 29).

The main drawback, however, is that a comment cannot be place on top of another icon. For instance, if a user wants to see health information, turns the layer on, but cannot place the text comment window on the exact place, having to click next to it. Thus, when having a crowded information area, it becomes a real problem (Figure 30), because users tried several times to click on it and the information window opens, annoying them for not being able to perform the wished action of entering the text comment on the exact place.

Figure 27. (Left) Text comment window cut.

Figure 28. (Right) Text window icons do not disappear after other command

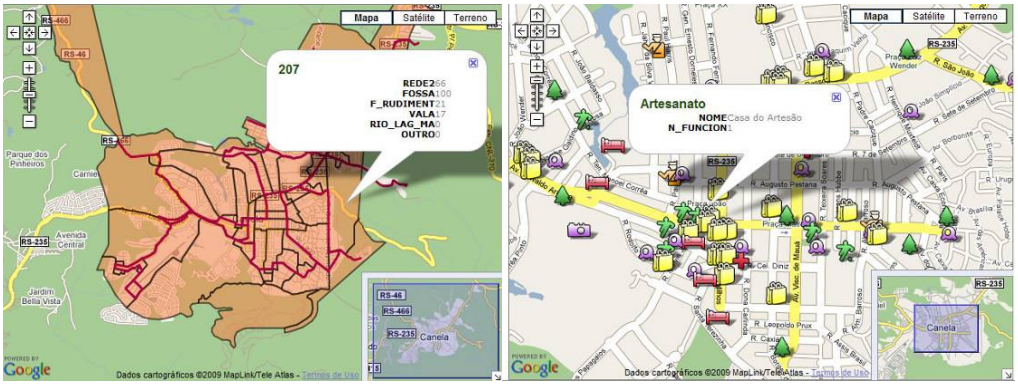


Figure 29. (Left) It is not possible to access information of the layer overlapped.

Figure 30. (Right) It is not possible to do a comment on top of an icon or beside on a crowded area

In general, users had difficulties to:

- Use zoom: in a great number participants had difficulties in using the zoom levels. When changing the zoom, felt lost with the new map extend and had difficulties to familiarize with it again
- Find a place on the map: showing that just a map with street names may not be enough to users easily find places of interest
- Realize how to do: one user said that if the observer were not there to explain how to use she would have not be able to do it alone
- Find the help page: the same user said there should be a clear and explicit how-to-do guide
- Read the information: one user found the font size too small
- Edit the text: one user wanted to use italic for a scientific name text entry.

Specifically, in the open questions 8 and 9, regarding improvements, the users remarked:

- Include place's and street view's pictures
- Include more information, as street lighting
- More zoom levels
- Better icons legibility
- Implement for real and connect with the city Web site
- Tutorial on how-to-use
- Mechanism against repeated entries
- Update some information, for example the natural resources GI layer
- Measure distance tool
- Other topics, like special information for tourist visiting the city
- Zoom to extend layer.

Regarding the evaluation criteria, following discussion is based on the questionnaire answers. However, is important to say that many are subjective, qualitative and interrelated. So the results should also be understood as a whole.

a. Cost of Entry

The prototype was implemented using open source software and components as the MySQL database and open Web services. Thus it is available at no cost. Just the Internet connection is compulsory. Programming took around 30 hours only.

b. Intended Users

Participants were mostly people with university education, as is clear from the professional background list on table 13. The neighborhood shows a diverse spatial distribution within the city. Also the age range is wide. Thus, we believe they are typical of those potential active l users.

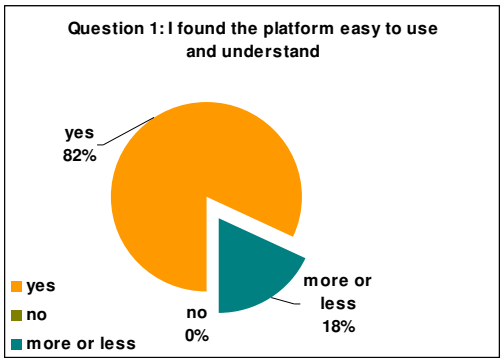
It is interesting that most of the users are unfamiliar with GIS, only 9 of 22 have experience with GIS or CAD (Computer Aided Design), and just 2 do not access Internet daily. Despite this, most users start to use the system without any problem. Probably it is due to the familiarity with online mapping services.

Sex		*Profession*		*Neighborhood*	
Male	11	Civil Servant	8	Non informed	6
Female	11	Architect	5	Centro	5
Total	*22*	Engineer	3	Vila Maggi	4
Age		Politician	2	São Lucas	2
Average	41.36	Accountant	1	Vila do Cedro	2
Median	42.5	Administrator	1	São João	1
Maximum	58	Retired	1	Palace Hotel	1
Minimum	24	Doctor	1	Loteamento Central	1

Table 13. Participant's background

c. Easy of use

Most users found the Web application easy to use. Results from question 1 - *I found the platform easy to use and understand* - show 82% said yes. However when asked if other people would do it easily there is not the same consensus, just 64% said yes (Figure 31 and 32 respectively). This does not mean that users seem averse to the application. But rather worried about the Internet access, population wealthy and education, as some mentioned. Also on how quickly people would be able to learn how to use it, and how much would it cost to use this application.



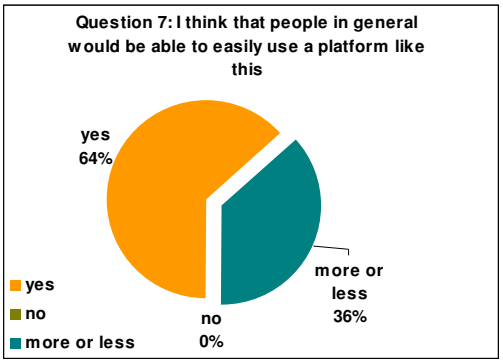


Figure 31. (Left) Graphic of question 1 and Figure 32. (Right) Graphic of question 7

d. Satisfaction

Besides the observer notes on users' emotions and expressions while doing the test, they were asked what did they like more and what did not, as shown on table 14 (question 11). In average, users reveal satisfaction with the easy of use, information available, and interactivity. Several said that they liked everything.

Question 3 (Figure 33) – *I would like to use this platform often to give my opinion* – evidence that they enjoyed the Web 2.0 PPGIS, as 95% said yes. And question 6 (Figure 34) – *I think that people in general would like to use a platform like this* – show again they are not so sure about others in using it, as just 68% answered yes. Once again, this reveals concerns on how much people see other people interested in engaging.

	What did you like more and what did not?
1	With the street names it is easy to localize.
2	I liked everything.
3	The easy access.
4	Open public information.
5	Solutions for the control of the city.
6	-
7	The ease of use.
8	I liked everything, very interesting and complete.
9	-
10	I liked everything in general and would not add anything at the moment.
11	In this first contact I did not found anything difficult or that I disliked.
12	It is easy to use.
13	Easy discussion and open information to citizens, projects the city in the Web, without cost to the user. As Internet access may be a problem to others, I suggest implementation of public Internet points.
14	The easy access and accurate information.
15	It is easy to access information. But I think is lacking clarity in the ways to use it.
16	-
17	It is easy to understand.
18	The contributions could be able to help the public administrator to apply the resources in the right places and prioritize issues.
19	I liked much the map and the satellite image.
20	I liked the interactivity idea.
21	The ease of use.
22	-

Table 14. Question 11: What did you like more and what did not?

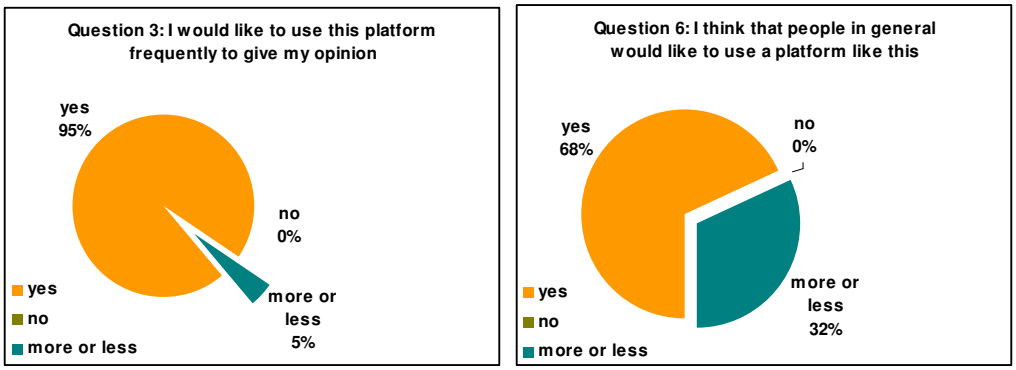


Figure 33. (Left) Graphic of question 3 and Figure 34. (Right) Graphic of question 6

e. Usefulness

Usefulness was direct measured from question number 10 - *Do you think this platform could be useful for Canela? What for?* - Answers are shown on table 15, and as a whole are all positive answers pointing out the use for communication channel, administration surveying, or connection to the citizens with government. A user specifically said it could strengthen public participation on the decision making. Furthermore, everybody answer yes to question 2 - *I found the information interesting and important*.

Question 4 – *I think this platform can increase public participation in decision making* – was 95% affirmative. And question 5 – *I think all municipalities should have a platform like this available for community* – had 91% yes (Figures 35 and 36 respectively). Thus, based on the public opinion, we can consider the Web 2.0 PPGIS achieves the goals of participatory planning.

	Do you think this platform could be useful for Canela? What for?
1	Very good.
2	Yes, because of the information available.
3	It would be the eyes of the municipal administration.
4	It could increase participation and the responsibility of the community in the decision making.
5	Yes, for administrative checking.
6	Quick and efficient communication channel for problems detection.
7	For participation with suggestions and opinions, modern channel of communication and information, for administrators have feedbacks of the actions and evaluate new ways.
8	With the information available is possible to evaluate the most problematic points.
9	-
10	Yes, the user would have real participation in the problems of the city.
11	In the touristy attractiveness divulgation, where the visitor would have the necessary information for a good stay in the city.
12	A way to administration hears the community and if possible does planning according to the suggestions.
13	Up-to-date information and connection to the citizens, to receive suggestions, denunciations.
14	Yes, to access city detailed information.
15	To suggest easily and to evaluate, open channel of communication more efficient.
16	Yes.
17	Yes, if well revealed the community would be able to actually engage.
18	Public administration would have community input with more efficiency to be able to do something.
19	To define which are the priorities and the best for the city.
20	It would improve participation on the decision making.
21	Yes to drive decisions.
22	-

Table 15. Question 10 - Do you think this platform could be useful for Canela? For what?

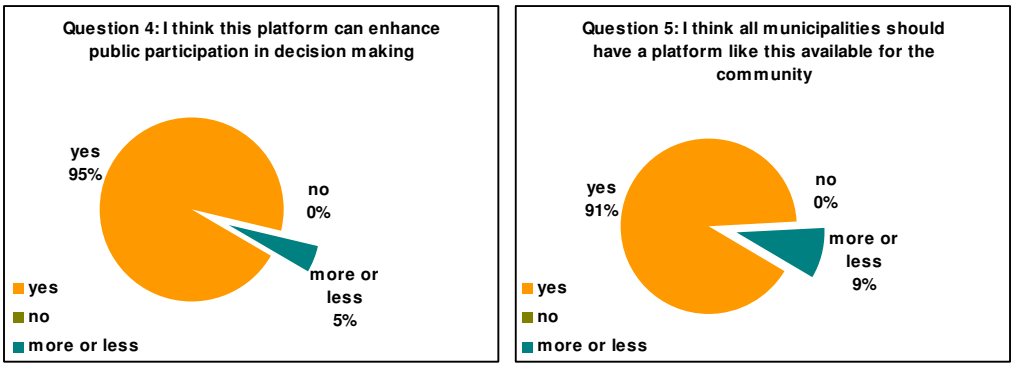


Figure 35. (Left) Graphic of question 4 and Figure 36. (Right) Graphic of question 5

f. Efficiency

Efficiency refers to the ability to fulfill its roles and objectives while taking a slight amount of resources. We consider that the Web 2.0 PPGIS is efficient since it proved to be useful, users were very satisfied in general, and it uses free resources for implementation.

Finally, the contributions of the evaluation workshop can be summarized as follows:

- Evaluate the system on the way, making possible to improve it
- Provide hints on major application pitfalls that can be solved
- Tell community about the possibility of a Web 2.0 PPGIS platform and the benefits of GI layers available for public
- Helps capacitate the population to use the application
- Push the administration to carry out such system, as users were excited with the idea
- Encourage people to provide their opinion on issues affecting their lives

5 CONCLUSION

This study is based on three pillars: participatory planning, PPGIS and Web 2.0. Public participation is an integral part of planning and the main reason is that citizens know about local problems better than anyone else. PPGIS stand for the GIS application to support and strengthen public participation. Web 2.0 services and applications allow all web users to create their own data and make it available to others. We believe that PPGIS and Web 2.0 technologies help to develop alternative ways to make public participation easier, encourage public to engage more, and allow multiway communication within participants and with decision makers.

To prove the potential benefits of this approach, we developed a Web 2.0 PPGIS application and promoted an evaluation workshop. Despite of the possibilities, Web 2.0 PPGIS are uncommon at planning process, especially at countries like Brazil. So the main distinction of this project is to apply such technologies, at a basic but operative form, at a real world scenario to provide evidences on those affirmations.

On the presented Web 2.0 PPGIS, users can see GI layers, edit comments, and send them to the system. On the other side, feedback is stored at a database, and professionals and technicians shall be able to use the content for spatial analyzes.

Selection of functionalities, interface design, and interaction levels focused on the simplicity and ease of use and usefulness. The GI language is as neutral as possible to hold a wide range of users. The main advance from traditional public meeting is that information is available for the community 24 hours a day, rather than information presented in some minutes without chance of interchange and information understanding.

Practical usefulness was tested on the evaluation workshop to verify how the public use and understand the application. The results show that public found it easy to use, useful for communication and participatory planning, and that they were satisfied with the available information. On their opinion it could improve their participation on decision making.

On our understanding, the workshop confirmed the potential of Web 2.0 to PPGIS and the potential of PPGIS to participatory planning. Users' comments were relevant to planning issues and users had not big problems using the system. Besides they show in the questionnaire answers satisfaction and excitation on a possible real implementation.

Obviously the current version could be improved a lot, as discussed on the results section. The tools available at this version are not many, but they can grow without difficulty, according to the demand. It could add a chat room or discussion forums or instant messaging, for example. It also could allow drawing lines and polygons, and measure of distances. Again, the workshop explicitly provided hints on future roles and functions needs.

Next research questions may focus on how to embed this interactive participation practice into the governmental institution, decisions on trust and reputation issues, and on how to deal with user's entries when it is not geographically related or the location is just estimated. Embedding the platform supposes a person responsible for filtrating comments and promoting discussions, an official feedback from government to participants, roles to avoid potential abuse by people and data trust. Decisions on trust and reputation refer to which information should be available and to what extend users profile should be public.

Besides, further work should observe technicians on the use of the user created content to better organize the feedbacks in a useful way for spatial planning. By observing the practical use of the users entries would be possible to check if it can lead to changes on decision making or not. Once the potential is proved to help engage more people and make communication easy, but still there are no evidences on how it would affect planning decisions.

To conclude, we believe that one of the main benefits of Web 2.0 PPGIS is to present relevant information that was not previously available using the technological capacity of GIS, and to promote communications among users and with decision makers in a more interactive and straightforward way. A Web 2.0 PPGIS like the one presented demonstrated to provide a useful approach for engaging the public in participatory planning. It is easy to set and understandable by nonexperts and can be easily applied on other contexts.

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APPENDIX

I. Implementation Details

This annex provides implementation details and code functions developed in the context of the Canela PPGIS Web Application.

- *Client-side scripting functions in JavaScript:*

- loadLayers()
  Fires on document load. Performs a *getLayersByTopic.php* request, and builds the layer tree from retrieved data.

- addComment()
  Fired when user submitting a new comment. Calls *addComment.php*.

- userLayerSwitch()
  Fired when user clicks on a "Comentários dos participantes" layer checkbox. Calls *getCommentsAsKML.php* so user data can be added to map overlays.

- *Client-side Google Maps API functions.*

To embed a custom Google Maps on the Web application (or Web site), first one have to create an API key for a specific URL address, and add the Google code to the page. Than to add functionalities to the custom map, as for example a zoom overview control, have to add JavaScript functions to the code. Many GMaps pieces are made available on the Web by developers. Some examples of the GMaps functions used are (Williams, 2008; Google, 2009):

- GSmallMapControl()
  Creates a control with buttons to pan in four directions, and zoom in and zoom out.

- GHierarchicalMapTypeControl()
  Constructs the control. By default, the G_HYBRID_MAP map type is made a child of the G_SATELLITE_MAP map type. If this is not wanted, the relationship can be removed by calling the clear Relationships() method.

- GOverviewMapControl()
  Creates a collapsible overview minimap in the corner of the main map for reference location and navigation (through dragging). Unlike other controls, you can only place this control in the bottom right corner of the map (G_ANCHOR_BOTTOM_RIGHT).

- GIcon()
  Creates a new icon object. If another icon is given in the optional copy argument, its properties are copied, otherwise they are left empty. The optional argument image sets the value of the image property.

- GGeoXml(urlOfXml)
  Creates a GOverlay that represents that XML file.

- *Server-side PHP code: classes and methods*

- Db.class:
  - Select(SQL) → data_struct
    Retrieves data from MySQL database.
  - Insert(SQL) → bool
    Saves data into MySQL database. Returns TRUE if succeeded.

- Json.class:

    - Encode(data_struct) → string
      Serializes a PHP structure to a JSON formatted string (i.e., prepares data to be consumed by JavaScript at client side).

- User.class:
    - signUp(form_data) → bool
      Adds a new user.
    - isValidUser(string, string) → bool
      Searches for user and password in the database.

- Comment.class:
    - add(form_data) → bool
      Adds a new user comment.
    - getTopicComments(int) → data_struct
      Get all user comments from the named topic_id.

- Layers.class:
    - getTopics() → data_struct
      Get all topics.
    - getTopicName(int) → string
      Get a topic name. The topic_id must be specified.
    - getTopicLayers(int) → data_struct
      Get the layer descriptions from a specific topic.
    - getLayersByTopic() → data_struct
      Get all the layer descriptions, grouped by topic.

▪ *There are also on the server side three exposed services URL that can be queried remotely:*

- getLayersByTopic.php
  Returns a JavaScript Object Notation (JSON) structured data with all the layer descriptions grouped by topic.

- addComment.php
  Accepts form data with comment details (user, text, location, and topic, for example) and inserts it to the database.

- getCommentsAsKML.php
  Returns a KML containing all user comments from the named topic_id, produced in real time from database contents.

II. Evaluation Workshop Questionnaire

This annex is a copy of the original paper questionnaire participants answered in the evaluation test (in Portuguese).

Você concorda com essas afirmações?

1. Achei a plataforma fácil de entender e usar.

( ) sim ( ) não ( ) mais ou menos

2. Achei a informação disponível interessante e importante.

( ) sim ( ) não ( ) mais ou menos

3. Gostaria de usar esta plataforma com freqüência para dar minha opinião.

( ) sim ( ) não ( ) mais ou menos

4. Acho que esta plataforma pode aumentar a participação pública na tomada de decisões.

( ) sim ( ) não ( ) mais ou menos

5. Acho que todo município deveria ter uma plataforma como esta disponível para a comunidade.

( ) sim ( ) não ( ) mais ou menos

6. Eu imagino que a maioria das pessoas estaria interessada em usar uma plataforma como essa.

( ) sim ( ) não ( ) mais ou menos

7. Eu imagino que a maioria das pessoas poderia usar com facilidade uma plataforma como essa.

( ) sim ( ) não ( ) mais ou menos

Responda:

1. **Você acha que falta algo nesta plataforma? O que?**

2. **Você acha que algo poderia ser melhorado? O que?**

3. **Você acha que uma plataforma como essa pode ser útil para Canela? Em que sentido?**

4. **O que você mais gostou e o que menos gostou na plataforma?**

Muito obrigada pela sua colaboração!