

Web-GIS Based System for the Management of Objections to a Comprehensive Municipal Land Use Plan

Pablo DÍAZ

Department of Agroforestry Engineering, University of Santiago de Compostela
Lugo, 27002, Spain

Jorge PARAPAR, Juan TOURIÑO

Department of Electronic and Systems, University of Coruña
Coruña, 15071, Spain

and

Inés SANTÉ, David MIRANDA, Rafael CRECENTE, Marcos BOULLÓN

Department of Agroforestry Engineering, University of Santiago de Compostela
Lugo, 27002, Spain

ABSTRACT

The development and approval of a comprehensive municipal land use plan is a long and arduous process that requires great effort from local administration, particularly in small municipalities with a shortage of resources and expert staff. Besides, because it is necessary to engage citizens in the plan development process, they must be provided with access to all the documentation and means required to participate. To this end, an application based on Web and Geographic information System technologies has been designed to promote the dissemination of urban information and to enable citizens to register objections to the land use plan during the different phases of the planning process, as well as to answer those objections.

Keywords: web-map server, e-administration, local e-government

1. INTRODUCTION

The development and approval of a comprehensive municipal land use plan is a long and arduous process requiring great effort from local administration and technical teams. Such an effort is even greater in rural municipalities with low population, lack of resources, and a limited technical and administrative team. For this reason, there is an increasing demand on tools that support the land planning process. Geographic information Systems (GIS) have traditionally been used in daily operations of government and public administration [1]. However, there are a large number of small municipalities in which the lack of resources or expert staff who can use this technology makes GIS implementation difficult.

In addition, it has been observed that there is a need to encourage a higher participation of citizens in order to improve the outcome of municipal land use plans and to help technical teams identify the most sensitive planning issues. Web technology has shown to be a very useful tool to provide public access to information and research data, which were so far available only for technicians. With the implementation of web-based GIS products, this capability of the web has been extended to geographical data and issues. Web-GIS based solutions provide a low-cost, efficient way to deliver map

products to users [2]. When applied to land planning, Web-GIS systems open the land use regulation process, previously constrained to professionals, to the whole population [3]. Web-based GIS technology offers an effective medium for public participation [4], since users can access GIS data and maps without having to own GIS software in their computer. In this way, citizens can have access to planning information and be more informed of the progression of land use plan elaboration, which increases involvement of stakeholders in the decision-making process. Sharing urban planning information is a requirement for information society development [5], and the use of spatial information tools in e-Government for citizens supports the goal of participatory democracy [6].

On the web, there are a large number of websites that allow users to query geographic information related to urban characteristics; for example, <http://gis.co.humboldt.ca.us>, <http://gis.jp.gobierno.pr/website/pri/Pot/viewer.htm>, or <http://santiago.tracasa.es/?lang=cas>. Some examples of this type of application can be found also in the scientific literature, among which the web-GIS based Urban Management Information System (UMIS) of [7], which integrates the digital base map and statistical data of a city and offers a variety of querying and reporting options, the web-based GIS developed by [8] to provide authorities with information, data, and guidance on the sustainable management of urban soils, the evaluation of CAD/GIS/BIM open web services integration for urban data management carried out by [9], and the WebGIS described in [5] for sharing information about the Beijing Master Urban Planning. Some of these applications are specifically aimed at supporting urban planning. [10] describe a web-based system with a GIS component, designed to support decision making within the UK planning framework by making environmental information accessible and by carrying out three planning functions: pre-planning enquiries, development control decisions and strategic planning. [2] presents another Web-GIS based Urban Planning and Information System, used by the authorized technicians of the Municipal Corporation to get a visual display of all day-to-day queries, maps and maintenance reports. Some web-GIS focus particularly on encouraging public participation and engaging citizens in urban planning. One example is the Web-based GIS for public participation in urban planning and management developed by [4]. [11] describe three web-based public participation GIS applied to local,

regional, and national land planning problems as an example of 'cyberdemocracy'.

However, we have not found any reference to public GIS-web applications that allow users to register objections during the land use plan development. To our knowledge the most similar system is the GIS-web application described by [12] and [11], which allows the people of the village of Slaithwaite, in the UK, to visualize maps and enter in a form suggestions for the improvement of their village. The authors identified the following advantages of web-based approaches as compared to traditional methods of participation: meetings are not restricted by geographical location, the public has access to the information about the issues being discussed, the information is available at any time of the day and every day, and citizens can express their opinion in a relatively anonymous and non-confrontational manner.

Pursuant to the urban law currently in force in the study area, one of the main forms of public participation in the municipal planning process is the registration of objections or allegations at different stages of the comprehensive land use plan development. This work stems from the need for automation in administrative procedures, including the development, registration and collection of objections, as well as the answer to those objections. In order to make an objection, citizens require the availability of a great deal of information. This information is usually stored in paper format in the town council, but citizens cannot take the documents to their residences, which limits the time available to citizens to review the relevant documentation. For this reason, the resulting objections are often unfinished or do not reflect the real situation. The easiest and cheapest method to obtain such information for both technical team and citizens is through the web. Geographic viewers and web servers provide information in a more visual and interactive way, and enable the overlay of information layers selected by the user. For this reason, we developed an application based on Web and GIS technologies as a means to encourage public participation, bring available documentation closer to citizens, and provide citizens with a mechanism that allows them to make and submit objections and to receive the answers to their objections. This tool aims to be of use to both the general public and technical teams, by facilitating and speeding up the management of and answer to citizens' objections, among other administrative procedures.

The objective pursued with this application is to encourage information disclosure regarding urban planning at the municipal level and general municipal geographic information, which makes it easier for citizens to raise objections and provides them with the means to justify and verify their demands. Thus, public participation will be encouraged and transparency in land use plan development will be guaranteed.

This application is a multiplatform, cheap, and easily adaptable and extendable tool due to the use of free software, architecture and design patterns, software development frameworks and widely known GIS and web tools. The application is fully implemented in free software. The main reason for having used this kind of tool is the cost saving, both in licenses for the specific software programs and in the operative systems in which they are run. Another advantage is access to the source code, which offers the possibility of customizing the application for each municipality in order to adapt it to possible specific

requirements. Given that the application is programmed using free development software, it can be distributed more easily and implemented in any organization without additional cost or the need to ask for permission for its use. Fully implementing the application in free software is possible because of the advanced stage of development of free GIS tools, even in the web environment [13].

In the next section we describe the design of the application, including the technologies and tools used to build it, its potential users and the main functionalities of the system. Then, we describe the implementation of the application in a Spanish municipality, which has allowed us to draw a series of conclusions to evaluate the future extension of the application to the rest of the municipalities in the region.

2. SYSTEM DESIGN

The application is structured in two big blocks related to the two main general requirements of the system; management of objections and query of geographic and alphanumeric information associated with the land use plan. The first block comprises the web application for the management of registration, answer and other administrative procedures related to objections, and a map viewer that allows users to visualize the geographic information needed for the development of the objection report. The second block corresponds to a geographic server that provides access to geographic information totally independent of the previous block and makes the attribute information related to the geographic features and text documents of the plan available.

Architecture

The implementation of a system with these characteristics requires the contribution of several technologies and a correct coexistence among them (fig. 1). All the tools used to develop the application are free software, with the resulting advantages of cost saving and accessibility to source code previously mentioned.

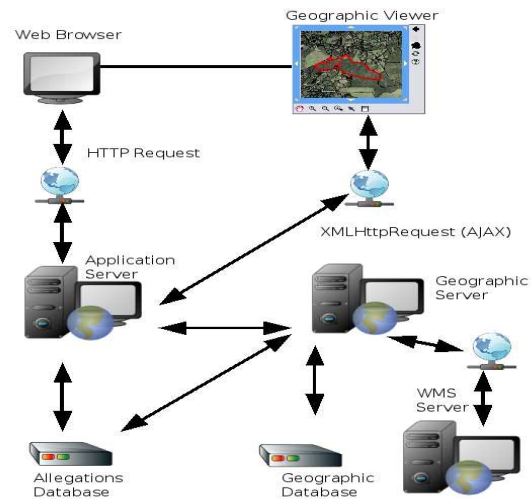


Figure 1. General scheme of the system architecture

The programming language used was Java for the J2EE platform (Java 2 Platform, Enterprise Edition), which allows a modular, portable and scalable design [1]. The following

software development frameworks were used:

- 1) Struts, which provides a total separation between the appearance and the functionality of the application through the design pattern known as MVC (Model View Controller) and, therefore, the achievement of easier maintenance and extension capabilities.
- 2) Spring, which manages all the transactional processes between the databases, both the geographic database and the objections database, and the application. In addition, Spring provides security support and user control through its security module, called Acegi.
- 3) Hibernate, which allows us to perform an object-relational mapping between the different tables of the database and the objects of the java classes implemented in the application.

Data was stored in two geographic databases. The first one comprised all the geographic information layers that were collected or generated for the land use plan, while the second one was used to store information related to the objections, the interested citizens who raised them, and the answers to those objections, as well as the geometry of the parcels involved in the objections. Both databases were implemented in the DBMS PostgreSQL with the spatial extension PostGIS, which has a BSD license. We have chosen this DBMS because PostGIS is already in an advanced phase of development and includes a large number of functionalities. Since this system does not support raster data, the GDAL library (with X/MIT license) has been used to write and read raster maps.

All this information and tools must be provided through servers. In this case, we decided to use two different servers. One server, Tomcat, was used to support the application, and the other one, Apache, was used to provide the geographic information. MapServer was used as a web map server due to its capacity to support OGC (Open GIS Consortium - <http://www.opengeospatial.org/>) standards and all major GIS formats, and to work directly with PostGIS and GDAL.

To develop the geographic viewer, we used the DBOX library, which can make requests directly to a Mapserver server. Such requests to the map server are made through AJAX, creating the URLs by JavaScript and submitting them using XMLHttpRequest requests. Although a desktop GIS application is not indispensable to run the application, GIS software was needed to develop the application. QGIS was used for this purpose.

This architecture allows for a total independence of the platform in which the system is implemented. A type of architecture called "Architecture three thirds" was used to make the integration and scalability of the application easier. This technology paradigm shift consists in splitting up the technical architecture into three layers; visualization, business logic, and control layers. With this scheme, we avoid the modification of the three layers every time a change is made in one layer.

Use Cases

Three types of application users have been identified: visitors, citizens and technical team. In the 'technical team' group, technicians and administrators are differentiated. Visitors comprise users who access the web but are not registered in the application. They can just query geographic and alphanumeric information. Citizens are users registered in the application, who are therefore allowed to make objections. Technicians are

the persons in charge of reviewing and answering the objections, and of making the information generated in each phase of the plan available. Administrators are responsible for managing the application. Figure 2 summarizes all the actions that the different users can carry out. In this figure, the users at the bottom level have also the use cases or functionalities of the upper level. Thus, administrators include the functionalities of technicians, who in turn have the functions of the citizens, who incorporate the visitors' actions.

Tool functionalities

Any visitor can register in the system by entering his or her personal data in order to be able to carry out the actions allowed to citizens. Subsequently, the citizen must locate geographically the parcel or parcels that cover the area affected by the objection with the help of the geographic viewer, in which the municipal orthophoto, the cadastral map and the map of zoning categories, among other layers, can be visualized. It is also possible to locate the parcel by introducing the cadastral reference. After that, a form is opened in which the text of the objection must be written. The user can attach a maximum of three files with additional information (fig. 4), which may include the maps of the concerned area generated with the geographic viewer. When data entry is completed, the citizen can check the generated file with the objection report in order to finally submit it to the technicians of the Municipal Corporation via web. Once the objection has been submitted, the citizen can verify the state of his or her objection at every moment. The system provides access to objection reports via secure web pages, such that only the corresponding citizen and the technical team can access them. The basic functionality of technicians is to review and answer the objections. Moreover, because the possibility of making an objection must not be restricted to Internet users, technicians can register citizens who make an objection in paper format and introduce their objections in the web application. Finally, technicians are responsible for making the documents generated in each phase of the plan accessible through the website. In addition to the functionalities of the aforementioned users, administrators have the capability to manage technical staff.

In short, the application functionalities can be divided into three classes: public functions, internal management, and geographic viewer. Public functionalities comprise all the actions that citizens can carry out:

- 1) Querying geographic and alphanumeric information included in the land use plan.
- 2) Locating parcels in the map viewer by using their cadastral reference and retrieving their alphanumeric attributes.
- 3) Registering a user.
- 4) Querying and modifying user's personal data.
- 5) Making objections and attaching additional information. Objections can deal with changes of zoning category in a parcel, errors in parcel location or delimitation, different location of cultural heritage elements, delineation of protection areas, proposals for new developable areas that observe the conditions established in the urban law, inaccuracies in the text documents of the plan, affectations of a parcel not considered in the plan, etc. Additional documentation can include maps generated with the geographic viewer. Figure 3 illustrates the output of this function.
- 6) Checking the state of the objection.
- 7) Checking the current development phase of the land use plan.

Internal management functionalities include the functionalities that are only accessible to the technical team and the administrators:

1) Entry of citizen, technician and administrator users.

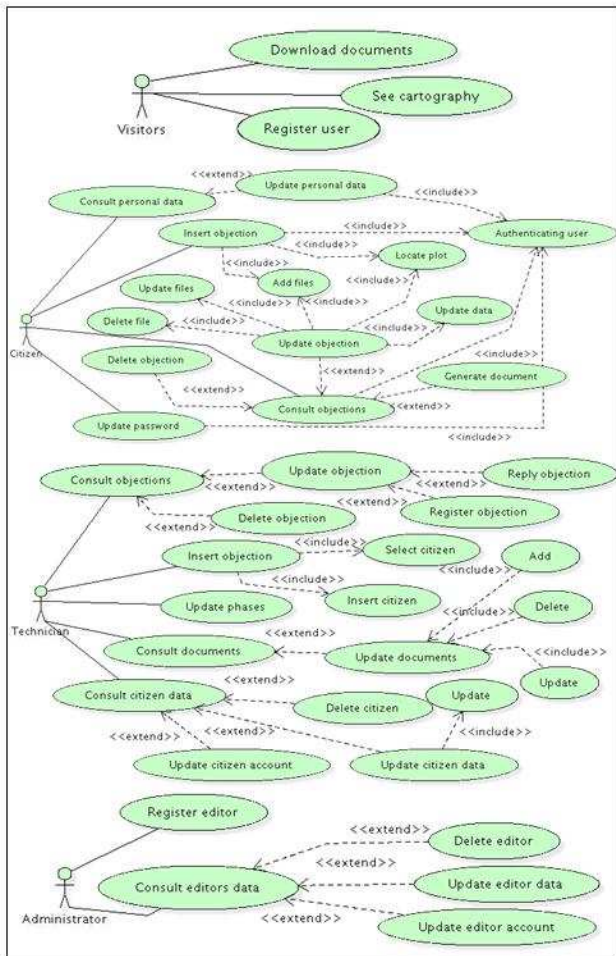


Figure 2. Use case diagram

- 2) Query of citizen data.
- 3) Collection of objections and associated documentation.
- 4) Entering, modification, and submission of answers to objections.
- 5) Determination of the current development phase of the land use plan and of the time length of each phase.
- 6) Management of the text documents available for downloading in each phase.

The geographic viewer functionalities are available to both public and internal users and comprise the spatial location of the objection area, the retrieval of information about the affected parcels and their zoning regulation according to the land use plan, the measurement of distances, the query of graphical and text documentation of the plan, and the visualization of general geographic and attribute information of the municipality. All these functionalities add to the typical functions of a GIS for map visualization and browsing, such as zoom and pan operations, spatial queries and retrieval of attribute information. General municipal information includes data stored in the local geographic database such as road network, hydrography, topography or land use data, and data from WMS services of

different regional and national organizations, among which orthophotos or cadastral maps. The use of WMS and WFS standards and the advance on Spatial Data Infrastructures allow us to easily extend the number of information layers available on the viewer. The user can turn map layers “on” or “off”, depending upon his or her needs. This information can be used by the citizen to justify his or her claim. For example, measuring the distance from a parcel to the road network, to the closest river or to some cultural heritage element will allow the user to verify if the impacts assigned to a parcel by the plan are correct. This aims to satisfy the principles of e-Governance, where informed decisions usually require specialist information [10], which gives citizens a good background for participating in the plan development. The citizen will also be able to check whether the information used for the development of the plan faithfully represents the real situation. Thus, technicians will be helped by citizens to identify errors and validate the information used in the land use plan.

GUITIRIZ TOWN COUNCIL OBJECTIONS TO A COMPREHENSIVE MUNICIPAL LAND USE PLAN PUBLIC EXPOSURE FROM 07/10/2008 TO 25/12/2008		
Mr/Mrs: Rodríguez Gómez, Zacarías		Id00049
ID Card: 00000000T		
ADDRESS: Labradra nº 8, Guitiriz - Lugo	POSTCODE: 11347	
PHONE: 900112214 / 901112233		
PARCEL IDENTIFICATION		
ZONE: 0	POLYGON: 120	PLOT: 235
OBJECTIONS:		
The highlighted parcel is close to the urban settlement of Trasparga, that is why the inclusion of this parcel in this urban town is solicited. An air photography is attached to verify the proximity of the parcel to the urban area.		
ADDED DOCUMENTS:		
1.- Foto aerea Trasparga		
2.-		
3.-		

GUITIRIZ, __19__de__Novembro__de 2008

SEÑOR ALCALDE-PRESIDENTE DO CONCELLO DE GUITIRIZ

Figure 3. Example of an objection report

3. SYSTEM IMPLEMENTATION

Galicia is one of the 17 autonomous regions of Spain. Autonomous regions have the legal competence to regulate land use and urban planning. The Galician government enacted a law in 2002 (Law 9/2002 of urban planning and rural environment protection in Galicia) that constrained all the municipalities of the region to develop a comprehensive municipal land use plan called Municipal Regulation General Plan (MRGP) before 2006, pursuant to the rules established in the mentioned law. Currently, only about 21 out of 315 municipalities have approved this plan. For this reason, the Galician government is promoting the development of tools that facilitate the development of MRGPs and speed up the administrative procedures. The system presented in this paper has been applied in Guitiriz, a rural municipality with a limited technical and

administrative team, with the objective of evaluating the functionalities of the tool in order to decide on its subsequent extension to all the Galician municipalities in which an MRGP is currently in development or proceeding process (42 out of 315 municipalities).

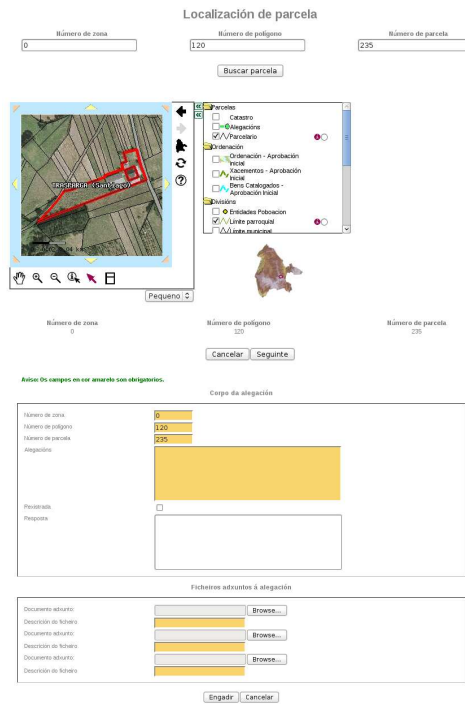


Figure 4. Geographic viewer and web form for objection submission

Law 9/2002 establishes an administrative procedure for MRGPs that includes several stages. The first one is the advance phase, where the strategy, guidelines, and general objectives of the plan are outlined. The Advance document must be exhibited to the public during a minimum period of one month, during which proposals or suggestions to the plan can be made. However, legally these suggestions do not have to be answered. The second stage is the initial approval phase, during which the land use plan document approved by the Galician government is exhibited to the public for a minimum period of one month and a maximum of two months. During this period, objections to the plan can be made by citizens and different associations. The objections made at this stage must be answered individually by the technical team. Finally, the town council and the government carry out the provisional and definitive approval phases. Consequently, law 9/2002 essentially provides for public participation in the following stages: in the advance phase through the development of proposals or suggestions, and in the initial approval phase through the submission of objections. Although in the description of the application, we only made reference to objections, the system can be used for the management of proposals or suggestions during the advance phase.

Following the administrative procedures to raise an objection, citizens must fill in an official form provided by the town council, to which additional documents that contribute to clarify the objection can be attached. Once the objection period has finished, the town council should submit the objections to the technical team, who would produce a technical report about the

objections made. Based on this report, the technicians of the Municipal Corporation should send an individual answer to every citizen who made an objection. Currently, objections and reports are manually developed and processed. The high volume of objections usually managed in each phase of public exhibition of the plan, and the limitations of the technical staff in such a small municipality cause a delay in administrative procedures. Yet, a quick management of objections is essential to cut down the time needed for plan development and approval. This is confirmed by the fact that the time for plan development and process varies to a large extent among municipalities. The data related to the MRGPs for the municipalities of Castroverde and Páramo are shown as an example. The MRGP for Castroverde was one of the first plans approved in the region. In spite of that, the administrative procedures extended from November 2003 to March 2008, with the following time distribution: 10 months for the advance phase, 20 months for the initial approval phase (during which 697 objections were made), 12 months for the provisional approval phase, and 11 months for the definitive approval phase. The MRGP for Páramo is at the other extreme: the process began back in 2002, when law 9/2002 was enacted, and is still in the initial approval phase. As can be observed, the initial approval phase, which includes objection development and resolution, is one of the most time consuming stages. Hence, the objective of this web-GIS based system is to improve the performance of the municipal department responsible for plan management and to provide citizens with complete, accurate, and updated information in a quick and easy way, which allows them to make better decisions.

In the municipality of Guitiriz, the MRGP is currently in development process; more specifically, the process is in the initial approval phase. The plan has been developed by a company that worked with the University in the application design. The website was implemented in the web server of the town council and used to manage citizens' objections during the initial approval phase of the land use plan for a period of two months. During this period, approximately 400 objections were processed via web, which involved a 50% decrease in the mean time of management.

4. CONCLUSIONS

This paper presents a computer application based on GIS and web technologies to help citizens make objections to comprehensive land use plans and, therefore, to facilitate and encourage public participation in the plan development. In addition, the application increases the accessibility of information related to urban planning, allows the user to know the status of the planning process, and speeds up the handling of plans, which consequently increases citizen influence on municipal planning and guarantees transparency in the plan development process (e-democracy).

Directly entering objections in the system by citizens implies a saving of time and money, in addition to continuous database updating. The system will be particularly useful to those citizens who are currently living outside the municipality affected by the MRGP. The system makes the information accessible to the general public and allows citizens to participate in the plan development process. In this way, the interested citizens can participate from anywhere at any time, without attending meetings or going to a public register at a particular time and

place.

The objection forms, the length of the plan development and proceedings phases or the available information, among other factors, vary greatly from one municipality to another. For this reason, an easily adaptable and customizable application has been designed by using software development frameworks and splitting up the system architecture into three layers, which separates the business logic from the visualization of the processed data. That is to say, the modular structure of the system allows us to change a specific component without having to modify the remaining ones, which gives the system the characteristics of portability and expandability, such that it can be easily adapted to the inherently different needs of the municipalities. Moreover, because most municipalities in Galicia are small, and have low population and adjusted budgets, the use of free software, which involves considerable savings in license costs, was the best option in this case. The use of free software was possible because of the increasing potentiality of this kind of tools in the field of GIS-web.

Given that the elaboration of geographic data is a very expensive task, making the large amount of data generated during MRGP development available to the public gives this information higher usefulness and allows us to exploit it for many other applications.

A future research line is the extension of the application functionalities by providing the application with capacities that allow citizens to design their own alternatives by using the information available on the website to obtain their desired planning scenario.

5. REFERENCES

- [1]D. Caldeweyher, J. Zhang, B. Pham, "OpenCIS – Open Source GIS-based web community information system", **International Journal of Geographic information Science**, Vol.20, No.8, 2006, pp. 885-898.
- [2]G.K. Tripathy, "Web-GIS based urban planning and information system for municipal corporations – A distributed and real-time system for public utility and town planning", **Geospatial Application Papers n°35**. Available at <http://www.gisdevelopment.net/application/urban/overview/urbano0028pf.htm> [11-1-08]
- [3]H. M. Jacobs, "Planning the use of land for the 21st century", **Journal of Soil and Water Conservation**, Vol.47, No.1, 1992, pp. 32-34.
- [4]A.Yaakup, J. Jama'an, Y.A. Bakar, S. Sulaiman, "Web-based GIS for public participation in urban planning and management", in: **ASIA GIS 2001** June 20-22, Tokyo, Japan, 2001.
- [5]D. Anrong, W. Lei, S. Huizhen, H. Haoying, "Study on sharing digital urban planning information based on WebGIS", **Proceedings of SPIE**, Vol.6421, 2006, pp. 64211V-1 – 64211V-4.
- [6]K. Strande, "E-Government for e-Citizens – NSDI as tools in good governance examples from eNorway and Norway digital", **V1 Magazine**, November 2008. Available at http://www.fig.net/pub/monthly_articles/november_2008/november_2008_strande.html [11-20-08].
- [7]M. Ozturan, B. Egili, F. Bacioglu, "Web-GIS based urban management information system: the case of satellite cities in Istanbul", **Management Information Systems 2004: GIS and Remote Sensing**, Vol.8, 2004, pp. 13-21.
- [8]I. Hossack, D. Robertson, P. Tucker, A. Hursthouse, C. Fyfe, "A GIS and web-based decision support tool for the management of urban soils", **Cybernetics and Systems: An International Journal**, Vol.35, 2004, pp. 499-509.
- [9]A. Lapierre, P. Cote, "Using open web services for urban data management: A testbed resulting from an OGC initiative for offering standard CAD/GIS/BIM services", in: **Urban and Regional Data Management. Annual Symposium of the Urban Data Management Society** (pp. 381-393), Stuttgart, Germany, 2008.
- [10]M.G. Culshaw, C.P. Nathanail, G.J.L. Leeks, S. Alker, D. Bridge, T. Duffy, D. Fowler, J.C. Packman, R. Swetnam, R. Wadsworth, B. Wyatt, "The role of web-based environmental information in urban planning – the environmental information system for planners", **Science of the Total Environment**, Vol.360, 2006, pp. 233-245.
- [11]S. Carver, A. Evans, R. Kingston, I. Turton, "Public participation, GIS, and cyberdemocracy: evaluating on-line spatial decision support systems", **Environment and Planning B: Planning and Design**, Vol.28, 2001, pp. 907-921.
- [12]R. Kingston, S. Carver, A. Evans, I. Turton, "Web-based public participation geographic information systems: an aid to local environmental decision-making", **Computers, Environment and Urban Systems**, Vol.24, 2000, pp. 109-125.
- [13]L. Gonçalves, M. Cordero, R. Crecente, D. Miranda, "GIS proprietary versus free: a comparative study using Geomedia Professional and Grass", **International Journal of Geoinformatics**, Vol.2, No.2, 2006.