Web-GIS Platform for Green Infrastructure in Bucharest, Romania

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ABSTRACT

In the last decade, reducing urban pollution and improving quality of public spaces became a more and more important issue for public administration authorities in Romania. The paper describes the development of a web-GIS solution dedicated to monitoring of the green infrastructure in Bucharest, Romania. Thus, the system allows the urban residents (citizens) to collect themselves and directly report relevant information regarding the current status of the green infrastructure of the city. Consequently, the citizens become an active component of the decision-support process within the public administration. Besides the usual technical characteristics of such geo-information processing systems, due to the complex legal and organizational problems that arise in collecting information directly from the citizens, additional analysis was required concerning, for example, local government involvement, environmental protection agencies regulations or public entities requirements. Designing and implementing the whole information exchange process, based on the active interaction between the citizens and public administration bodies, required the use of the "citizen-sensor" concept deployed with GIS tools. The information collected and reported from the field is related to a lot of factors, which are not always limited to the city level, providing the possibility to consider the green infrastructure as a whole. The "citizen-request" web-GIS for green infrastructure monitoring solution is characterized by a very diverse urban information, due to the fact that the green infrastructure itself is conditioned by a lot of urban elements, such as urban infrastructures, urban infrastructure works and construction density.

Keywords: Web-GIS, Monitoring, Green Infrastructure, Citizen Request

1. INTRODUCTION

This paper describes the development of a web-GIS solutions in which inhabitants from urban areas may be involved in decision support of public authorities regarding monitoring and future development of green infrastructure of the city by collecting information directly from citizens. The main problem identified by this paper is the poor infrastructure development of spatial databases present in the public sector and their connection with web-GIS solutions[1]. One way of solving problems resulting from collecting relevant information is represented by proper adaptation and improvement of classical interaction solutions between citizens and authorities in charge presently used. Starting from the decision markers characteristics identified at the local authorities level, the proposed solution will improve communication with urban residents, while involving them in decision making process.

This paper and presented web-GIS solution is developed under the project "Urban Climate Study of Bucharest, Romania (UCS 2013)" developed by the scientific research project number IZERZ0_142160 within the Romanian-Swiss Research Programme 2011-2016 (RSRP 2011)[2]. One of the main objectives of the project is to implement modern urban climate strategies in Romania and to analyze in detail and improve the urban climate situation of Bucharest as far as urban heat island, air pollution, heat stress and human comfort is concerned.

1.1 Public authority context

From the series of components that influence the possibility of implementing web-GIS solutions in these institutions are: historic operation age of institution, added-values promoted, present working procedures in relation to direct beneficiaries, willingness to acquire new knowledge and implement innovative solutions (both in social and technological terms), the urban residents characteristics and their knowledge, the need to promote credibility and visibility of the institution.

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In terms of implementing new solutions at public authority levels we can identify the following risks:

- interest / disinterest of citizens ;
- requested time new solution implementation;
- decreased / increased implementation costs;
- potential disturbance in the institutional work flow;
- visual compromising in case of wrong solution implementation.

These risks can be avoided through effective use of information received from citizens and their adaptation to the specific institution. From the perspective of local authority perspective is necessary to consider based on cost-benefit analyze financial implication efforts and risks offered by a web-GIS application[3]. Services provided by the local authority to citizens currently require a regroup in a unique portal, in order to request various services and requests[4].

At the same time must be taken into account that the main beneficiary green infrastructure are the citizens, who in addition to regular use wants in specific time moments the solving results of certain problems and/or improve certain facilities. Present days the between public authority and citizens, in Romania, is done by two main ways: unidirectional and bidirectional[5]. The same type of communication can be identified also local municipality for example and other public institutions. In unidirectional communications model the municipality provides or requires the citizen's attention to various information on provided service such as rethinking of green space, new building deployments etc. Citizen only choice is to accept changes or refuse it due to communication slowdown. Bidirectional communication and feedback from an online platforms allows citizen to inspect features characteristics and changing aspect, to submit questions and suggestions in order to improve the entire service. This aspect can be archived by certain use of web portals with are equipped with digital maps and other relevant spatial information. In addition for almost cases data, expressing satisfaction or dissatisfaction of the population on the entire public service, are collected in a low and in some cases is missing. This requires the use of new concepts such as "citizen-sensor" that can transmit in real-time the information to operator using interactive web-GIS platforms[6].

1.2 Green infrastructure context

The European framework as well as the current legislation in Romania recommends that the amount of green space per inhabitant in cities must increase, with specific targets, namely minimum of 26 sqm/inhabitant before 31.12.2013. However, these goals were not met, and the current development is a slight decrease. For example in 2014 Bucharest the value is approximately around 23 sqm/inhabitant[7]. The need for a monitoring of green infrastructure in Romania is recognized in several programmatic documents and legal provisions, though the term green structure is not explicitly mentioned. Thus, the Law no. 24/2007 and Law nr.313/2009 related to the regulation and management of urban green spaces regarding the regulation and management of the green spaces in urban areas and the corresponding Technical Norms for its implementation created the legal framework for a systematic inventory of the urban green spaces. The green spaces inventory is the reference for further development of the urban planning activities that should take into account the green structure concept. However, the Ministry which initiated the Local Green Space Inventory did not establish a centralized public list with the cities which adopted the Register. Meanwhile, cities which adopted the first version of the Green Spaces Inventory (in 2010 or 2011), did not update it, even though the legislation specifies a 2 years period for updating. A general problem seems to be that the cities find it too time consuming to develop and maintain their local green space inventory, and that they do not see benefits from maintaining it that may justify the costs and efforts. Official statistics[8] are revealing green spaces of 4839 ha, starting from 1996 until 2009, indicating an increase by 4506 ha green areas from 2010 until 2012. However, various papers are indicating drastic decrease of green spaces by about 50%, from 3471 ha in 1989 to 1708 ha in 2004.

Due to the fact that green infrastructure domain is very complex the literature abounds in different studies referring to the green space quality and characteristics. For example Balram and Dragićević[9] describes the people's generally perception of the green space. They concluded the fact that in common manner, people evaluate the quality of the green areas according to different aspects such as: vegetation diversity, green space surface, presence of water source near green space (river or lake), recreation area presence (children playground), and walkways network. Meanwhile Amati and Yokohari[10] considers that green space doesn't serve only as a decorative purpose and acts as a socio-economical system with a wide range of functions and services. The "green space can generate a high level of social participation and collaboration among individuals". Chen, Adimo and Bao[11] evaluated the esthetic quality characteristics such as visual,

auditory and olfactory elements of green spaces and they proposed a quantitative approach for assessing the natural aspects using infield questionnaires and visual photo, due to the fact that these areas generate high level of citizen participation.

2. WEB-GIS APPLICATION DEVELOPMENT

Urban areas have as a main characteristic housing or population density that reside in the area, but also a set of mandatory municipal services such as green areas distribution, public transport or public utility grid. At the local level, all urban services are interconnected at a higher level due to the fact that they operate in a limited space with predefined information exchange. Some monitoring problems arise when the same municipality is trying to manage and preset information in a logical manner about multiple aspects of the same areas. A GIS system in the first instance can provide the ability to manage and present information in a logical manner about many aspects of the same areas. It can display real-time information on green infrastructure characteristic, e.g. green space usage indicators presented by municipal authority in charge in parallel with reports that comes from citizens.

Before designing and current use of a web-GIS application in necessary to express in a coherent manner the ultimate goal of the system, which are the human resources and financial implications of users, respectively the type of application that is fully compatible. Also should be defined exactly which data sets can be analyzed, interrogated, monitored, interpreted, processed or replaced by the final user – the citizens. Whether we discuss an application designed for urban planning, green infrastructure management or public awareness the conditions and development trends of web-GIS solutions should be followed in real time

2.1 Geodatabase structure

For the project development Bucharest area represented the pilot study surface due to the fact that contains necessary information provided by public institutions with the possibility of preforming various interaction and analyses by citizens.

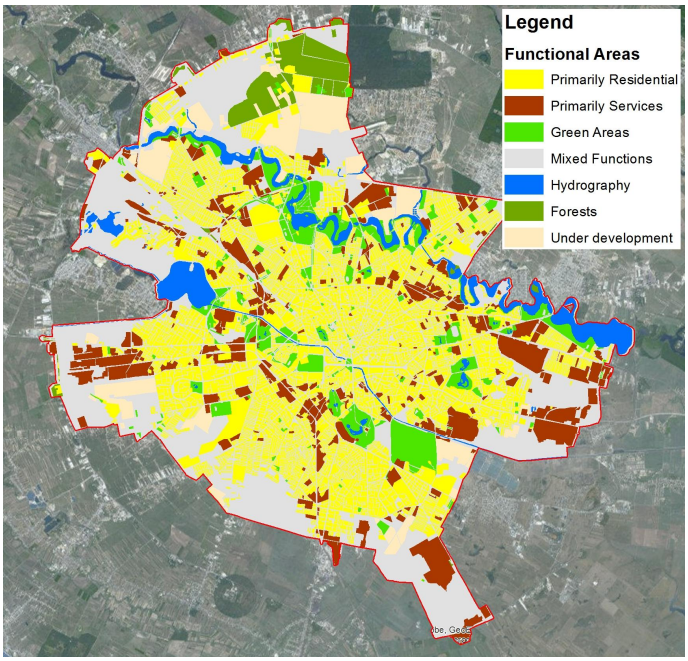

Figure 1. Bucharest urban area / study case area

As a general concept spatial database contains both high-density data, strictly localized in the urban area of Bucharest City and buffer information such as peripheral area, connecting roads and railways. The proposed architecture in this spatial database consists of seven modules arranged according to defining characteristics (Table 1). For the study to be as conclusive in terms of future visual identity made by citizens in the web platform, the database was designed with accuracy as high as possible.

Table 1. Database architecture (MCD Modules)

Module	Description
Urban component	Describe the urban structure geometry such as street network, parcels, buildings, green spaces, etc.
Urban structure characteristics	Contains punctual, linear, or buffer information related to events that are taking place in the area. (public works, accidents, etc.)
Green infrastructure	Describe geometric elements like coverage, alignment, or water network pipelines, nodes, manholes, branching points, hydrants, etc.
Green infrastructure works	Contains punctual, linear, or buffer information related to green infrastructure changes
Citizens requests	Contains punctual and descriptive information related to citizens requests
Municipal intervention	Contains punctual and descriptive information related to municipal interventions (administration work intervention)
Documents	Contains publics documents that can be offered to users, such laws, open spatial data plans, etc.

Later for the construction of green infrastructure network, ortophotoplans 2012 edition coverage was used, provided by National Agency for Cadaster and Land Registration[12] and "Green Cadaster" source, namely The Local Inventory of Green Spaces[13] developed by Intergraph Romania (project beneficiary Local Council, Bucharest Municipality). This two data services set contains green infrastructure visual characteristics for a coverage of approximately 285 square kilometers.

Figure 2. Sample from The Local Inventory of Green Spaces, www.regver.pmb.ro Project beneficiary Local Council, Bucharest Municipality

2.2 Bucharest web-GIS concept

The interactive web-GIS application includes a vectorial base map and an ortofotoplan coverage with a request form which citizens can report and monitories different aspects related to green infrastructure. In addition with their requests, citizens can view previous requests made by other residents of the urban area. The web base map provides graphic representation of green area objects, roads, sidewalks or build structures such as public or private constructions. The entire design of this web application was based on citizen-sensor concept because some information provided by citizens will not have a technical description but it will be received in real time with a very high degree of accuracy. Storing these types of information from citizens may lead to proposing new solutions lean towards citizen, whether discussing public policy or a public service. Any citizen with Internet access who lives in the pilot study area could easily view map of their own neighborhood and report problems from the field.

By filling and submitting an online request, users are able to see his own application but also the past interventions from the public authority, classified into three categories: Assigned – the request is assigned at the municipality level for future solution (further the citizen can complete his own request with other comments and recommendations related to his report); Unassigned – the request is unassigned at and the user will not be able to post new comments until the request is assigned; and Closed – the request was solved by authorized person in charge. Return confirmation form can simplify the procedure of communication between citizens and public authorities. In the future when the application will be implemented at municipality level, all requests will be sent directly to the server by the body responsible. To classify in a logical forms the requests, we decided at this level that the forms will be predefined, and detailed description of the request will remain as comments. For example we mention selective predefined request: green area quality, vegetation visual status, vandalism, problems due to human activity, unforeseen natural effects, etc.

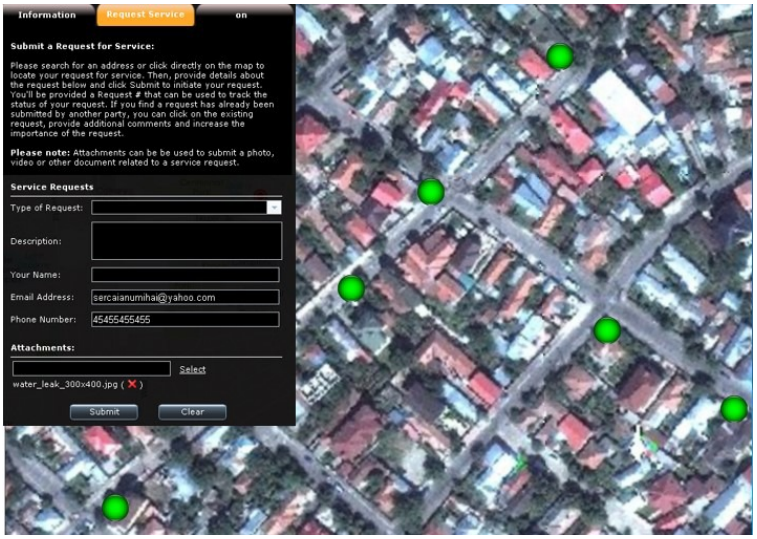

Figure 3. Citizen request solution for Bucharest Green Infrastructure web-GIS application

From the municipality functional aspects the web-GIS solution must return unique requests IDs. Possible errors that may occur are mainly due to duplication of postal codes and address. For example if the green plots are numbered identically in municipality internal register, due to human error in the previous inventory process. These errors can be avoided if the application takes into account the user geographic location.

Based on approach classification in terms of solutions that are based on citizen involvement in collecting information and also reporting problems from field by them, the can be included in "collaborative"[14] and "contributory"[15] categories (long-term visualization, reporting, real-time reports, voluntary involvement), and with the possibility of extension to other public or private activities sectors.

Another that require attention is represented by the perspective that database and all connected application need to be secure against theft or confidential information manipulation using overloading the system with false claims.

3. URBAN CITIZEN PERCEPTION

To identify the type of beneficiaries and assess people's perception about the possibility of implementing web-GIS solution, we conducted a field study census during period 01.09-01.12.2014 based on statistical approach. Questions contained in the questionnaire aimed to quantify public perceptions related to green infrastructure by four distinctive categories: green space placement; green space use; environment and the natural vegetation diversity. In addition, a set of questions were introduced to express the possibility and ways of involving citizens in the future decision process, using online solutions based conventional one. Processed questionnaire responses showed that citizens varies with local knowledge and experience to formulate answers:

- Green area from peripheral area are polluted;

- Municipal plans doesn't allow proper territory expansion;
- Aged vegetation is not properly tend;
- Existing application don't present field reality;

4. CONCLUSIONS

By increasing public participation in reporting the problems from green infrastructure will increase community interest towards the activities of municipality where requests are solved in a timely manner at a low cost. If local authorities will not develop and implement new solutions that will increase the amount of information collected from citizens institutional transparency will continue to be down due to lack of public confidence. New applications for citizens implemented in municipal companies should have a similar structure and interface applications already used by people regardless of their connection speed internet.

Analyzing municipal departments from Romania we can draw some important conclusions. For municipality ICT new technologies is not a priority because of internal financial policy. In terms of public relations department using modern technology is used to a minimum and limited to simple complaints. Long or incomplete response time leads to loss of trust citizens to the company. Filling up of simple online form does not automatically lead to the development department. This requires the opening of companies to customers using technologies that allow real-time feedback. This requires periodic public relations campaigns and customer information dissemination adapted to local aspects.

Implementation of information systems and a spatial database associated with the development of virtual infrastructure for dissemination of information will lead to the renewal of urban infrastructure, including public involvement in decision support. The project results prove valuable to a much wider range of users who use the internet daily, has a high amount of information that are local in nature and are willing to communicate to municipality. The aim of the project is more than to provide to citizens located in urban area the opportunity to interact with the municipality but also to improve quality of green infrastructure. This GIS solution helps citizens to perceive better municipality structure and institutional internal procedures.
Finally it should be noted that the research is interdisciplinary and complex enabling the development of future studies according to technological developments.

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