Starting a Spatially Enabled Society: a Web System for Collecting Volunteered Geographic Information in the Area of Public Security

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***Abstract*— A spatially enabled society provides to citizens, businesses and government access to spatial data regardless of computing platform. The article describes a collaborative Web system to gather geographic information about the area of public security and disseminate it at all levels of a society using Web 2.0 tools. The data generated by the user become another source of data for agencies involved in public security to use the information in order to try to minimize violence and allow citizens to protect themselves from criminality.**

Keywords- Volunteered Geographic Information; Web Systems; Google Maps; Public Security.

I. INTRODUCTION

Currently, the use of geographic information is fundamental to sustainable development as well as improvements in the making decision process by a particular organization, in which the factor "where" is important and precedent to perform an action on several sectors, such as public security, health, urban planning, deforestation control, agricultural production and others. The economic development, social stability, improvement of citizen's public security, and others can be reached by developing products and services that are based on geographic information collected by all levels of a society or government [1].

These actions can be facilitated by the development of a spatially enabled society [1]. In this type of society, spatial information is regarded as common goods made available to citizens and organizations to assist in developing techniques to support decision making [1, 2]. A spatially enabled society in the context of public security may be useful to bring citizens closer to police departments and improve the activities within these organizations. Any user may search for a service or information, which should always be available and reliable access [3]. Moreover, people can voluntarily contribute information to help security departments to make decisions based on volunteered information.

For the development of such society, it is necessary the use spatial data. These, in turn, need to have a certain degree of quality, sufficiently reliable, easily accessible and available in real time for use by that society [1]. Based on this understanding, Spatial Data Infrastructures (SDI) are being developed in many countries as a platform that improves the sharing, access and integration of spatial data and services. An SDI can also store spatial data and provide services of access to data supplied voluntarily.

In recent years, the amount of spatial data generated by the users has grown. Increasingly users are indexing content based on their geographic coordinates. With this new paradigm of spatial data production, the term Volunteered Geographic Information (VGI) has arisen, identified by Goodchild [4] as a new phenomenon to describe user-generated information, combining elements of Neogeography, Collective Intelligence and Web 2.0 [5].

It is possible to note an evolution in the treatment and production of spatial information. With the popularization of the Internet and the emergence of Web tools, it is possible to observe a breakthrough in the development of new technologies for the production of geographical information [4]. Considering that Web 1.0 initially assumed a unidirectional role only allowing users to visualize information, Web 2.0 plays a bidirectional role in which users are able to interact and provide information that can be accessed by any user who has access to the computer network.

The purpose of making a society become a spatially enabled one is to transform the citizen into a "voluntary human sensor" in the Web 2.0 world, providing information and reviewing information that has been contributed by other voluntary users. According to Georgiadou et al [6], the use of "participatory human sensors" can extend the power of action of ordinary citizens, improving the ability of citizens to directly influence the services performed by a particular organization.

The rest of the paper is organized as follows. Section II describes the main related work. Section III presents the motivations and objectives of the project and describes the case study developed. Section IV describes the methodology used and some conclusions are presented in Section V.

II. RELATED WORK

There are many works developed with the use of information technology and employing spatial data, applied in the area of public security. However, these works are ceasing

 ISBN: 978-1-61208-251-6

to be developed in a conventional environment of Geographic Information System (GIS) and starting to use Web 2.0 concepts and neogeography to produce data from ordinary citizens, i.e. without knowledge of specific areas of geosciences. Some examples of these projects are listed below.

The project Wikicrimes [7] main idea is the access to information and collaborative mapping of crime in a digital map using the Google Maps API. Any user with a mobile device or a computer with Internet access can cooperate with the system and seek information about a registered crime. This work contains functions to automatically validate registered crimes, display statistics of them and identify hot points of the city, i.e., identify areas of greatest risk, using an algorithm based on Kernel Map.

The project called "Paz tem voz – Mapa do Crime" [8] or "Peace has voice - Crime Map" in English is a project developed to collect volunteered information from police reports that the citizen was a victim or witnessed the fact. The system consists of a module of voluntary collaboration, functions for visualization of statistical analysis of recorded data and identification of homicide profile, such as age, crime motivation and weapon used. Moreover, it is also possible to make a complaint about theft, burglary and other crimes. The system uses the Google Maps API and is designed to meet the desires of the people of the state of Paraná, in southern Brazil.

The project CrimeViz [9], developed at the University of Pennsylvania, also uses the Google Maps API to provide digital maps of Washington, District of Columbia, United States. However, this study differs from others cited above in two aspects. Firstly, the CrimeViz is fed by official data of the District of Columbia and not by voluntary contributions. Secondly, it implements a panel of spatio-temporal analysis by day, month or year. This panel can be understood as a box containing a button to play, pause and continue. The user selects the unit of time (day, month or year) and selects the play button. Then, the system will display a color histogram representing the number of incidents that were reported and it is possible to view on the map a spatio-temporal analysis showing the data records in the last days, months or years.

The works cited above have great contributions to public security in combating violence. The work proposed here differs by proposing some contributions that are useful for approximating the population to police agencies by, for example, using concepts of Wiki in VGI data in order to make the citizen a reviewer of user-generated content. Another example is the development of a forum to discuss the recorded data, creating a collective intelligence that can be useful to perform validation of data, from the testimony of others or serving as collection for more information about a registered crime. Furthermore, in order to improve access to and dissemination of VGI data, an SDI is used for data storage. Finally, the potential of VGI in the area of public security can be validated based on some statistical analysis on the VGI data in relation to official bases of police agencies.

III. MOSSORÓ SPATIALLY ENABLED: MOTIVATIONS AND OBJECTIVES

The city of Mossoro, located in western Rio Grande do Norte state, in Brazilian northeast, is the second most populous city in the state and has a large growth related to industries and companies that have settled in the city such as Petrobras. In recent years the feeling of insecurity in the city has grown among citizens. The "Instituto Técnico-Científico de Polícia (ITEP)" or Scientific-Technical Institute of Police, an institute responsible for statistics from police reports, started to show alarming numbers in recent years related to the increase in crime in the city.

According to data from the Sangari Institute [10], the number of homicides in Mossoró city has been growing year by year. In 2009, 132 homicides were recorded. The number rose to 178 homicides in 2010 and to 196 homicides in 2011. In 2012, until September, 97 occurrences of homicide had already been recorded. Due to this alarming increase, the case study of this work is related to Mossoró city.

The aim of this study is to make the citizen a participatory "voluntary human sensor" in a spatially enabled society using Web 2.0 tools. Any user who uses a mobile device or a computer with Internet access can report problems of insecurity or register crimes in which the citizen was the victim or a witness. The data generated by the user are stored in a database integrated with a SDI, making it easier to search for data by the various organizations that have some direct or indirect influence in the area of public security and the dissemination of data at all levels of society, as well as avoiding efforts by users in creating repeated data. The user can record VGI data, participate in the forum of a registered data in order to enhance the data or provide other relevant information, and use Wiki services to review data from voluntary contributions, as it is done at the free encyclopedia, Wikipedia.

IV. MATERIALS AND METHODS

The collaborative systems can be understood as tools that support Web 2.0 resources and allow the direct or indirect interaction of a particular individual or of collective groups with any content available on the Internet [11]. This type of system emerged in recent years due to the advances in Web. Until recently, the Web was used only to provide information, making users only consumers of information. This phase is known as Web 1.0. With advances in technology it has become possible to interact with content published on the Internet. Blogs, Wikipedia, Email and others are examples that allow users to interact with content, setting up another phase of the Web known as Web 2.0. The system developed in this work uses technologies that support Web 2.0 capabilities and other tools needed for development, such as: (1) Apache; (2) Google Maps API version 3 for map viewing, statistical analysis and analysis of the most dangerous areas based on the algorithm of Kernel Map; (3) The programming languages Hyper-Text Markup Language (HTML), Cascading Style Sheets (CSS), Hypertext Preprocessor (PHP), AJAX, jQuery, JavaScript and eXtensible Markup Language (XML) were used for customization of the Google Maps API, development of collaboration module, interface and other features; (4) The Database Manager System MySQLServer is used to store

 ISBN: 978-1-61208-251-6

users' contributions and PHPMyADMIN is used as database configuration assistant.

The Apache server (or HTTP Apache server) is a free software developed by the Apache Software Foundation, and aims at processing information on the Web, i.e., it is a server responsible for answering Hyper-Text Transfer Protocol (HTTP) requests, Web standard protocol [12]. The system is available in the domain (www.ide.ufv.br/mossorocrimes) using a machine with Internet access as the physical server and the Apache as Web server.

This work used the Google Maps API v3 with support for browsers (Internet Explorer, Firefox, Safari, Opera and Chrome) and mobile devices with Android and Iphone. This API provides several features for viewing 2D and 3D maps, geocoding services, best route and others. Features of this API are used to perform statistical analysis of VGI data and risk analysis, i.e., determining the most dangerous areas in the city. To use the API it is necessary to possess a valid license key and provided by Google itself. This key is used together with JavaScript codes that can be loaded into the system. Google provides all documentation for use of the API and the resources supplied by it.

The collaboration module is a service offered by the system to collect VGI data. The user can provide textual information about an act of violence, insert videos and photos related to the registered act and use the forum to discuss the data, providing relevant information to help improve the quality of data. This module was developed with the programming languages PHP, JavaScript, HTML and XML, supplying the user with greater interaction to insert, update or criticize a VGI data.

Data collection is an important part of this work, because from them, it is possible to perform statistical analysis of VGI data and possibly infer about the potential of the VGI. Therefore, it is necessary to create a database allowing the authors to hold VGI data instead of them going to the Google server. The MySQLServer was used due to it being easy to install and use, being free software and having the PHPMyADMIN assistant that facilitates the creation, modification and settings of the database.

V. RESULTS AND DISCUSSIONS

The developed system consists of a prototype to collect VGI data and perform statistical analysis of VGI data and by geographic region. The software was developed to support requests coming from computers (laptop, desktop) and smartphones that support Android or Iphone operating systems. Fig. 1 shows the system interface that uses only HTML and CSS in its development to make viewing very simple in devices that have limited screen such as mobile devices.

The system provides two categories: security and others. At the time the user performs collaboration he can tell which category and type of occurrence that he will provide. The category "other" represents other data that have some connection with the area of public security, for example, report lack of lighting on a street. Fig. 2 shows statistical analysis on the collaborated data by categories and on users who cooperated more. Then it is possible to have a control over the most active users and filter, in the database, the information of these users in order to try to identify whether the user is collaborating to help or disturb police activities.

Figure 1. Interface of the system.

The identification of risk areas is essential when the topic is public security. The Google Maps API provides resources to implement services for risk analysis based on Kernel Map, which is a statistical method of estimation of curves, i.e., is plotted on the map using interpolation methods, the intensity of a particular phenomenon in the region [13]. The system has a button called "heatmap" to enables the function that implements the Kernel Map. Moreover, as the user moves the map it is possible to view the statistics of VGI data by region. Fig. 3 shows the use of Kernel Map in recorded incidents.

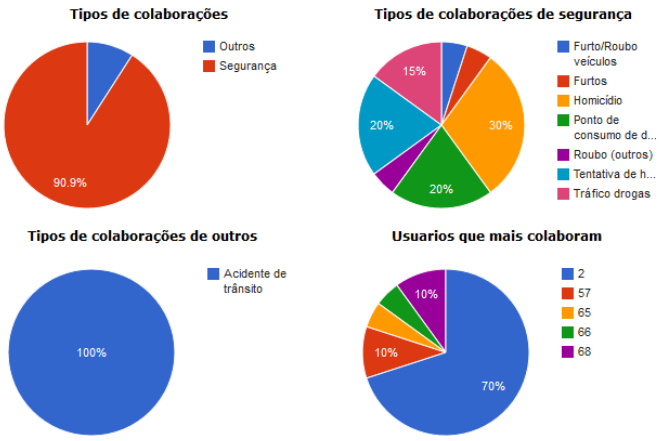

Figure 2. Statistical analysis by category and user.

Because there are few collaboration, it is not possible to infer any relevant result on the Kernel map. From the moment that there is more collaboration in the system it will be possible to see the color intensity by region.

The collaboration module is responsible for receiving contributions from users. To perform a collaboration is necessary that the user is "logged in" to the system so it is necessary a simple registration. This information is preserved and is not available at any time that the user is interacting with the system. After accessing the system using the credentials of the registration, the user can click in the “collaborate” tab and then click on the map to write a collaboration. The user can register and send textual information, photo, video or any other file. Fig. 4 shows the "infowindow" of collaboration module with the tabs to send multimedia files. Mossoró has Streetview service. The citizen can use this service to better identify the place for registration of the occurrence.

 ISBN: 978-1-61208-251-6

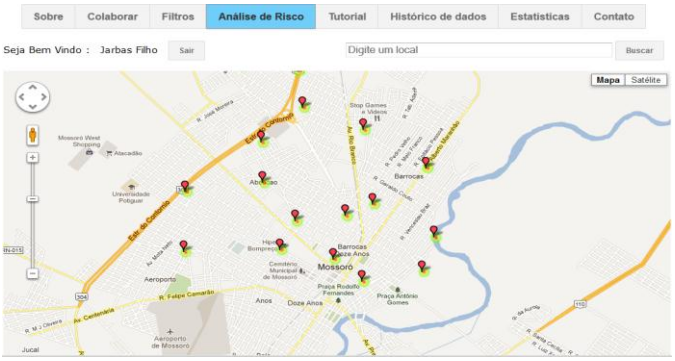

Figure 3. Risk analysis based on Kernel Map.

Once the user registers the collaboration by clicking on "send collaboration" it is created a forum about the data. To interact with the forum, the user must be "logged in" to the system. Therefore, any registered user can interact with other users and provide extra information that was not addressed in the description of the occurrence. This generates a collective intelligence about the data, similar to those that exist in relevant comments in posts on social networks, whose goal is to help in the description of a photo, text, video or other.

The system also provides access to all data recorded and it is possible to follow the updates in real time and analyze all data that have contributed to the system. Moreover, it has a data filtering service whose goal is to facilitate the viewing of specific data such as homicides, thefts and others. These data can be filtered and analyzed separately using Kernel analysis.

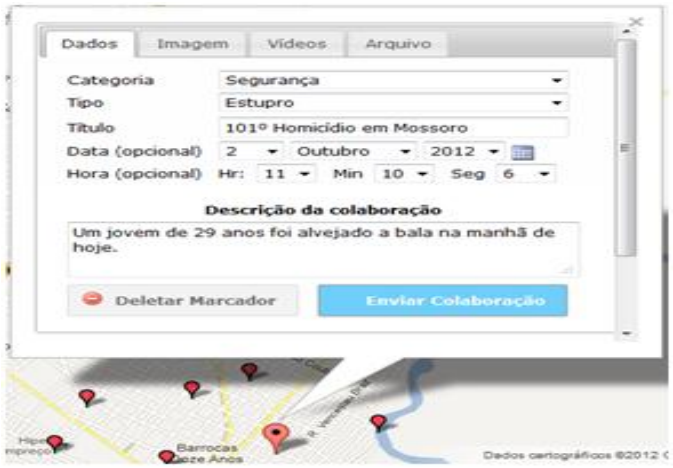

Figure 4. Infowindow of collaboration module.

VI. Conclusion and Future Works

A collaborative Web system is essential for citizens to share information that are often available on websites that do not have the knowledge of agencies in charge of public security. A society enabled with VGI data on public security can be useful for companies, citizens and government using another database to improve the decision-making process. VGI data being used at a local level, which is highly recommended, can provide a faster response to security departments than their own official data. Therefore, in an emergency situation it is possible to get better results in the execution of activities.

This type of system when ethically used can provide a satisfactory database for agencies responsible for security in a city and help people to protect themselves from violent places. In future work a Wiki module will be developed so that citizens can interact in order to improve VGI data quality and an SDI that will provide access to all the agencies. So at major events in the city, the agencies that are related to public security can use a database containing information from other sectors and improve their activities in combating violence. To validate the VGI data, statistical analysis will be conducted comparing the VGI data with official data to assess the impact of VGI in security.

Acknowledgements

This project was partially funded by CNPq, Fapemig, CAPES, Funarbe and the Company Sydle.

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 ISBN: 978-1-61208-251-6