Proceedings of 26th International Cartographic Conference - From Pole to Pole | August 25 - 30 ,2013 | Dresden Germany

Empowering Brazilian Unprivileged Communities with High Geotechnological Tools

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Abstract. Around the world new and amazing technologies is been developed for uncountable proposes. Unaware of this worldwide movement there are communities based on subsistence productivity, in the country, as well as families with very low education level and income in the urban area, that suffer from effects of uncontrolled "progress", such as urban expansion and housing speculation. Despite the conceptual distance between the high-tech and the unprivileged world, the reality shows that them both can benefit from each other. The article presents Brazilian experiences that uses high geotechnological tools such as satellite images, GPS, geobrowsers, collaborative internet maps, and others, for helping unprivileged communities to show and take their place in this new globalized world and to qualify their work and products, while empowering themselves to comprehend and effectively participate on a sustainable territory planning and management.

Keywords: informal settlements, Collaborative mapping, VGI.

1. Introduction

Each day more people have access to Global Navigation Satellite System (GNSS) and photograph disposals, internet, geobrowsers, Geographic Information Systems (GIS), remote sensing and many others technologies, due to its price decrease, specific applications dissemination, rise of geographical data offer, friendly interface increment, as to take for examples.

Poor communities have already access to high-tech devices such as mobile phones with digital cameras, computers and wireless internet, although some might need to use their school or other digital center to access it. The major challenge now is to make them an effective part of this new global scenario. Their participation on the community planning and monitoring is a crucial step towards the globally sustainable development. In countries like Brazil, those unprivileged communities frequently represent more then 50% of their municipality population. Due the lack of public government, their residents and some few professionals that work directly with them (such as health agents) are the only ones who detain the territory knowledge and they may have the help of new geotechnological tools to add value to this knowledge.

What we call high-geotechnological tools in this paper are those used to support location of events and features on earth, that can either be used to collect, store, visualize, access, process or analyze data related to a geographic position based on its spatial attributes.

2. High Geo-tech Tools

It is impossible to list here all devices, software and techniques that can be used with this propose. However, some are more popular, accessible or have high potential to be used at those unprivileged communities. Therefore we will briefly comment a few of these technologies.

2.1. Global Navigation Satellite System

The GNSS (Global Navigation Satellite System), ordinarily known as GPS (Global Positional System, developed by USA), comprehends a spatial component formed by 23 or more satellites, a control component formed by ground centers that monitor and regulates satellites orbits and operations, and a user component, where we find the signal receiver devices and techniques to improve position information. The GNSS, as it name says, is responsible for informing exclusively our position on earth. Adding processes (such as geometry calculation) and maps to the receiver devices, it is possible to obtain information such as velocity, area, route and many more. GPS, GLONASS (Russian System), GALILEO (European system) are GNSS that offer free signal code, allowing those who have a receiver in their mobile telephone or car navigation system, for example, to get positioning coordinates for free any time, any where in the world, as long as the signal is not blocked by a roof or a tree, for example. In general, these more popular devices work in an absolute mode, what means that it recognizes any one position, with a planimetric uncertainty of 10 meters, just by triangulating the signal of at least four satellites (Monico, 2000).

Mobile phones and vehicles with GNSS devices may also emit location data to processing centers, which can turn the data received into new information for their contributors or to the open public. The device owners don't even have o think about sending the data, they only need authorize its transmission and to have the appropriate program installed. Applications of these features are very popular for traffic monitoring (Waze[1] is now a phone application very popular in Brazilian metropolis) but may also be used for monitoring location of public transportation (function implemented in very few Brazilian cities) or to measure personal exposure to noise and create a noise pollution map (Maisonneuve, 2009). But the idea of been a volunteer in providing location information may be explored and many other situations, as points out Goodchild (2007) and Boulos *at al* (2011).

2.2. Geobrowsers

The coordinates of our locations on earth may also be easily accessed by geobrowsers. Geobrowsers are internet applications that presents maps and satellites images at a digital globe model. Some examples of 3D representations are Google Earth, Microsoft Virtual Earth, NASA Worldwind and of 2D we can list the Google Maps and the Microsoft Live Search Maps. They work as a geographic catalog on line, where users may find locations on maps through visual recognition or addresses, and may also identify its coordinates (Butler, 2006). On the other hand, besides the fact of having to be connected to the internet, geobrowsers are not committed yet with accuracy or data homogeneity. As a catalog, these are not their main priority. There are places in the world were are offered only small scale maps and low spatial resolution images. There are is also found places where street map features mismatch in more then 50m the satellite image, (taking as example the city of Camaçari, in Brazil – coordinates 12º41'51"S, 38º19'27"W), and there is no warranty of a maximum uncertainty of the position value for those areas where map and images match well. Despite these technical limitations, geobrowsers are extremely important to exchange and distribute information based on location, making location the main attribute of a search engine. Geobrowsers are also responsible for the exponential growth of popularity of geographic information science and they can also be used to distribute information produced by informal groups or individuals.

2.3. Remote Sensing Products

Satellite images and aerial vertical photographs used on geobrowsers are part of the science called Remote Sensing (RS). This kind of images can be used to visually identify features on the surface of the Earth (visual interpretation), as mentioned before, or, on the other hand, to find different kinds of patterns, based on algorithms that access each cell value that form an image. These images are the RS products, and they result of a complex

[1] http://www.waze.com/

and advanced technology. Images that we are already used to see on geobrowsers are obtained by multispectral sensors boarded at satellites. Those sensors register electromagnetic radiation of different wavelengths and transform, into matrixes of numbers, information that many times is impossible to the human eye to distinguish, such as the infrared radiation (Lillesand *et. al*, 2000). Therefore, the images presented on geobrowsers have originally much more information that we can see or access freely, but using this engine any one may intuitively apply image interpretation keys (helped with street vector information usually provided by geobrowsers) to find or explore their target, that could be their house, neighborhood, school surroundings, a home-work path, etc.

2.4. Geographic Information Systems

Along with the Remote Sensing science there is another field of work called GIS (Geographic Information System). Despite the multiple concepts of the abbreviation GIS, they all agree that it is referred to tools used for store, organize, access, manipulate, visualize and process a geographic data (Burrough et. al, 1998). GIS software can be very complex and specific for an activity, such as the Californian Fireman Department GIS (ESRI, 2012), but each day we find simpler and free access tools. That may not address all spatial based problems, but the simpler ones can be solved. Free software such as TrackMaker[2], which has interesting and very useful tools for GNSS beginners, or the TerraView[3], a free GIS software developed by the Brazilian Institute of Spatial Research (INPE). This software has recently improved it's performance and interface and is now part of national program of Brazilian Ministry of the Cities to promote de use of GIS among public management staff[4]. Differently from geobrowsers, GIS tools are a lot more powerful for map analyzing and presenting and, therefore, even the simplest GIS software still requires specific knowledge.

To achieve his level of interpretation and data organization the community should have among them a cartographer, geographer, urban planner or another professional trained at geographic information science. As Craig and Elwood (1998) alert, it is important that this professional really understands the community goals, otherwise the result can be a reproduction of a dominant and elitist power, and not a empowerment process. The Public

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[2] Available at: www.gpstm.com. Accessed February 2012.

[3] Available at: www.dpi.inpe.br/terraview/. Accessed February 2012.

[4] Programa Nacional de Capacitação das Cidades – PNCC. Available at: http://www. capacidades. gov.br/ Accessed April 2013.

Participatory GIS (PPGIS) initiatives are related to this idea of empowering and reducing segregation of marginal communities through participation and a geographical technological education (Sieber, 2006). It is a movement that has its origin in a North American university since midst '90s and it has been growing and spreading around the world since than.

In Brazil since 2001, with the approval of the Cities Statute, a federal law that defines policies for municipality management (Brasil, 2001), participation is finally one of the top challenges discussed among professionals, academy and city planning institutions. Promoting participation in Brazil is no long a single matter of democracy principles or a well known warranty for public actions better effectiveness, but it is also a matter of applying the law.

2.5. Collaborative mapping

Collaborative mapping is a brain new area of study. The term is used for the process of sharing user-generated geographical information. Crowd Mapping is an expression related to the term, but i is more used for a broader number and profile of collaborators, as the name suggest. Another related term, Community mapping, brings, on the other hand the idea of a process constructed by a group of individuals or entities while the term Volunteer Geographic Information (VGI) brought by Goodchild (2007) restrict the map collaboration to free will collaborators.

Applications that allow collaborative mapping are often referred to "as 'crowdsourcing' or 'participatory sensing' applications, since they are capitalizing on the power of the masses (or 'crowds') and relying on citizen participation to achieve their goals" (Boulos, 2011 ;2), therefore, they must be as intuitive to use as the geobrowsers. Applications such as the Wikimapia[5] project, one of the most popular in Brazil, brings the possibility of unprivileged communities to update their street maps, points of interest, health unities, and other places that, until then, were not seen in any map, bringing benefits, not only to the community, but also gives as a clear idea that each one of us may contribute, as Coutinho (2012) defends.

In order to promote the citizen participation we bring to notice in this paper where are and how are projects in Brazil using those high-geotech tools at unprivileged communities.

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[5] Available at: www.wikimapia.org. Accessed February 2012.

3. Methodology

At first the search was addressed to find and register, in a geographic database, Brazilian projects or publications that presents an experience of poor communities that have participated on the process of mapping themselves. For this task it was used first the internet search engines Google, Google Academic and Scielo. Many different Portuguese keywords related to the theme were used: mapeamento ou mapa colaborativo (collaborative mapping or map); mapeamento ou mapa coletivos (collective mapping or map), mapeamento voluntário (voluntier mapping).

Brazilian projects of collective maps were also searched using the search engine of the collaborative maps platforms Crowdmap[6], MapMe[7], Meipi[8] and WikiMapps[9]. The search engine for public collaborative maps of the platform GoogleMaps[10] was not found.

The Brazilian journal MundoGeo[11], one of the few publications that is specialized on GIS, had also each one of its 64 editions scanned for articles related to community mapping projects.

A catalog of Brazilian experiences with a representative number of contributions was created in order to help the research team to organize geographically collaborative mapping projects held in Brazil (Figure 1). It was necessary because most free collaborative mapping engines do not offer a search engine of public maps based on location.

Two other experiences, in which some of the authors have participated, are also reported in this paper (the beekeeper mapping and Salvador's carnival mapping).

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[6] Available at: www.crowdmap.com. Accessed October 2012.

[7] Available at: www.mapme.com. Accessed October 2012.

[8] Available at: http://www.meipi.org/meipis.php. Accessed October 2012.

[9] Available at: http://wikimapps.com/index.php/apps/listAll. Accessed October 2012

[10] Available at: www.maps.google.com. Accessed February 2012.

[11] Available at: http://mundogeo.com//blog/category/revistas. Accessed February 2012.

Figure 1. Screen capture of the collaborative map called Catalog of Brazilian Collective Maps < https://catalogodemapascoletivosbr.crowdmap.com/>, accessed october 29th of 2012.

4. Communities Experiences

Until October 2012, 28 communities mapping projects held in Brazil were cataloged: 6 national projects, 3 state level project, 5 inter-municipal projects and 15 local or municipal projects. We are absolute sure that there are many more projects on development but they have not yet been publicized in a way the presented methodology could find. We intend to continue feeding the collective map catalog and to promote its use by researches and collaborative map makers.

We selected, based on the diversity of its goals and technology used, some of these experiences found to briefly present them here.

The project found in the survey that fits better to the investigated theme is held on Rio de Janeiro slums, the WIKIMAPA project[12]. Its initial goal was to use an existent cartographic data to stimulate young community members to use mobile telephones to identify assets and to develop a system that would allow information editing and collaborative construction. However

[12] Available at: <www.wikimapa.org.br>. Accessed novembro de 2011.

he project scope has greatly increased, when the Youth Network faced a problem: the technical impossibility of marking places due to the absence of the slums in official cartography. Therefore, the Youth Network now has a larger mission with Wikimapa: create a new base map, overlaying the official one and enter primary and secondary streets, so they can finally map the locations of public interest and services.

Brazil - 2011 Rain[13] is a collective virtual map, which has as main objective to map flooding and landslides. Other categories related to rain are also mapped: like clogged drains, waste disposal sites, illegal occupations, burial sites and places where any one may give donations to help people affected by this kind of disaster. Map information may also be enriched by photographs, videos, reports in text, reports, aerial imagery and GPS collected coordinates, all sent through an application offered to be installed at a mobile telephone.

The Flood Project[14] is a fully collaborative project that aims to provide useful information and to connect people willing help those victims of flooding disasters in Brazil. A digital collaborative map is part of the project, and besides al the enrichment tools mentioned for the Brazil – 2011 Rain map, it also allows map collaborators to enter information and warns about danger situations via twitter: # projetoenchentes.

The OpenStreetMap[15] (OSM) is a collaborative project created to provide free and editable map of the world, inspired by websites like Wikipedia. The maps are created by the platform's collaborators, who may use GPS data, aerial photographs or other free source to enter their geographical data. From there, anyone can register routes (streets, highways, bikeways, bridges, walkways, etc.) and points of interest (public buildings, shops, hotels, schools, etc.). Marcel Wille, volunteer developer of OpenStreetMap in the Reconcavo region of Bahia, say that in various places OSM already has maps more complete then the ones found in browsers like GoogleMaps. According to Wille, this project enable many small towns in the country to have their maps on the Internet, many times with more accurate information than a commercial competitor. The base map data and other information from the OSM are licensed under Creative Commons Attribution-ShareAlike 2.0.

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[13] Available at: <www.chuvas2011.crowdmap.com>. Accessed December 2011.

[14] Available at: <www.projetoenchentes.radioramabrasil.com>. Accessed January 2012.

[15] Available at: <www.openstreetmap.org>. Accessed January 2012.

The project conducted by the Kabu Institute [16], located in an Amazonia portion of the state of Pará, was conceived for Kayapó indigenous by a company specialized in GIS. The Kabu Institute use geotechnology to assist in the preservation of the indigenous area. The Indians were able to use GPS devices to collect the coordinates of locations where there is some kind of illegal practice. Thus, information is added to maps and reports, developed by Kabu Institute, and sent to the Federal Police and to Funai (National Indigenous Foundation).

Rural communities on the outskirts of Santarém and Belterra, Pará, have collectively produced a map showing the impacts of soybean cultivation in the state west region. They have identified areas of deforestation and other environmental liabilities of this type of production, such as silting and rivers contamination by pesticides, roads blocked by plantations and the disappearance of traditional villages. The project, according to Greenpeace, which supported the initiative, have also mapped 121 communities, some of which had never been mapped.

Two other experiences were held by the authors of the present paper and presents unique aspects that we find important to comment. One of them is the construction of Salvador 2012 Carnival Collective Map. The project was proposed for a Facebook group of 1200 members, mostly middle class professionals, graduate students, researchers and professors, who were debating about inappropriate use of public areas during carnival, among other territorial related matters. Despite the many complements about the initiative, no members, besides the map creation team, collaborated to the map. The team was frequently promoting the post where the activity was proposed and had also published a quick guide to help those inexperienced with the creation of geographic information. But, the experience shows that constructing a collective map is not a natural and easy task, even among those who have interest about the topic being mapped and have good social, cultural and economic conditions, what also means more experience with high-tech devices and internet.

The other experience was conducted by Brito (2011) while creating and coordinating de the program called PNGEO (National Program for Georeferenced Beekeepers Registry) for the CBA (Brazilian Beekeeper Confederation). The PNGEO was created in 2007 and until January 2012 was applied at 11 Brazilian states. One of the program main characteristic is to have local beekeeper associations as its executive centers. The mapping process starts with the beekeepers and professional rural assistants training, which

[16] Available at: <www.kabu.org.br>. Accessed January 2012.

is offered by the CBA and state's rural assistance public institutions. During the training process the beekeepers and professional rural assistants start to collect geographical coordinates using GPS devices and to register information about beekeepers residences, apiaries, honey processing houses, water sources, vegetation species important for the honey production and contaminants elements such as open waste disposals, agrochemical farming, urban areas, industries and others.

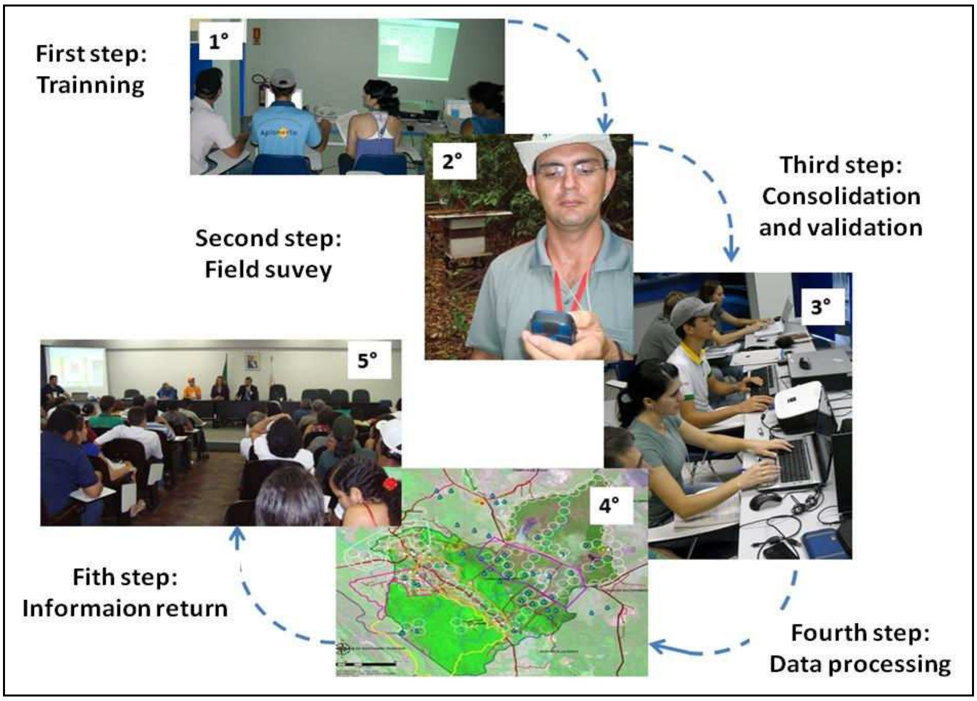

Figure 2. PNGEO/CBA program execution steps. Source: Brito (2011).

Notebooks and digital photograph cameras are also used at the PNGEO project to record testimonial videos, photographs, questionnaire forms and to run a free version of the TrackMaker software. When internet signal is available, the geobrowser Google Eath is also used as a plugin application of the software TrackMaker, allowing rural producers to visualize satellite images of their region underneath other vector data available at the software library or downloaded from the GPS devices. A Microsoft Access database form (previously prepared by the CBA) and the TrackMaker are used to clean overlaps, complete broken polygonal lines and to validate geocodes that connect geographical location data with attribute data from questionnaires. Afterwards, the tabular and graphical information are sent to CBA's team of GIS and apiculture experts to be analyzed along with other environmental and social economic information, producing a report that points possible improvements and a geographical data base for CBA planning and monitoring activities.

5. Discussion

GNSS technology are considered in most of the projects listed. Some used the signal receiver device that works for this exclusive function (mainly the rural projects), and others used mobile telephones that has a GPS receiver and an application that allows immediate transmission of georreferenced text, image or video data. Concerning this matter, it is important to know that data collected with a GPS for a local scale project, such as a neighborhood mapping, requires adjustments that can be made based on previous cartographic or remote sensing data. This is necessary because the 10 meters uncertainty of the system, added to building obstructions, may imply on referencing a bus stop on the wrong side of the street, for example.

Experiences found on the web and at journals show that non-governmental organizations and academic institutions are the ones that have been promoting the use of high geotechnological tools for community mapping projects. On the other hand, with the popularity and expansion of the communication industry mobile phones are now broadly accessed for people with low income, community leaders of a very poor neighborhood of Salvador, Brazil, say that near 100% of the adults residents heve a mobile phone with digital camera features. Smartphones with GPS receiver are still very few in these community. Access to internet is been highly improved in Brazil, federal and state programs have been promoting access to computers and internet at most of public school of metropolitan areas and municipal centers and at municipal officers. Brazilian cities Mayors have been also investing on creating digital centers with open access to these technologies. These school and municipal centers are been highly used by teenagers to participate of social networks and might as well be used to upload local information. This is a very new, and still expanding, scenario, what indicates that the geographical tools can already be exploited at under privileged urban communities.

Experiences promoted at rural areas by the beekeepers mapping program, the soy plantation impacts and Kaiapo's indigenes mapping projects show that rural unprivileged communities may be equally benefited from high geotechnology. All three experiences have in common the challenge to map large areas that has very low demographic density. They also produced cartography main features, such as tracks and community locations, that have never been mapped before and updated information about bridges and roads conditions, for example. Due the extension and the environmental focal point of the projects they also made more use of remote sensing products, although advanced analysis were processed by a specialized professionals that also joined the projects.

We believe that what is missing for middle class Facebook members, is also missing for most slums dwellers, poor family farmers and for our cities managers and authorities. They do not realize, understand or know the role that a territorial comprehension plays in planning, monitoring or managing neighborhoods, cities, states and countries.

On the other hand, slums dwellers are the ones more directed affected by the absence of the government in territorial planning and actions. This absence evidences are seen every where. They are even seen at city maps, where community features do not appear, highlighting their inexistence for the city that they physically belongs to. Their main problems are essentially physical: lack of sidewalks, of street pavement, of plazas, of drainage or sewage systems, presence of house flooding, of terrain sliding and many other problems. That is one of the reasons we believe that local geotechnological projects with unprivileged communities has a big chance of success despite the gap existent on their formal and technological education.

6. Conclusion

The experiences registered allows to presume that projects that focus on empowering unprivileged communities is mainly an education project. Therefore, it must start locally (specially in urban areas) and with a thematic focus (specially for rural communities), based on their previous knowledge and the community main needs. Who changes it locally thinking globally, will, in fact, change it globally.

On the other hand, continuous volunteer participation demands results. Local leaders are tired of meetings, labs and pilot projects that require a lot of their time and do not turn into any benefit to their community. To empower them it is necessary more then a set of printed maps, it's necessary to help them find their way to grow, to find technical help, to become part of a net of communities, to develop a direct channel to communicate with authorities, and geotechnological tools can help them do that. Projects are also betting to have more chances of success if focusing on training young citizens who has the time and curiosity to learn about high-tech tools. On the other hand, community leaders must understand the power of the geographical information. This gap between these two generation will soon vanish if older members work together with younger community members. The experiences studied shows that unprivileged communities now have access to geotechnologies and they know that a place in a web map may become a place in society.

Acknowledgements

The authors would like to thank PROPCI-UFBA for supporting the research presented in this paper providing a scholarship to the graduate student Daniel Reis.

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