The Voluntary Contribution of Citizens in Cadastre – Crowdsourcing in Cadastre

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Key words: Volunteered Geographic Information, Neogeography, Crowdsourcing, Cadastre

Suumary

The source, the use and the manipulation of spatial information have dramatically changed during the last decade. Online maps are designed by individuals. Geographic data is collected by non experts. The Volunteered Geographic Information is applied in many different fields and cartographic rules are chartered by volunteers. Only a few examples that indicate the new trend in GIS.

New trends have been introduced in land management as well. The main purpose of the land administration is the recording and dissemination of information about the ownership, value and use of land. (UNECE, 2005). As a consequence, the need for AAA cadastre has been urgent. Among the 6 billion parcels world-wide only 1.5 billion land parcels are formally registered (Zimmerman, 2011). Differences between inexpensive and in a relatively quick time cadastral survey with the aid of crowdsourcing should be balanced to the expensive, under specific regulations and legal principles survey by chartered Surveyors. "Crowdsourcing means that a task or problem is outsourced by an open call to the public rather than another body". This is the very first definition given to crowdsourcing by F.I.G. in its report titled "Rapid Urbanization and Mega Cities: The Need for Spatial Information Management" (Doytsher et al.,2010) in a way to approach crowdsourcing techniques to land management.

The scope of the paper is to present the first practical experiments which were carried out in Greece in an effort to engage VGI to Land Management. Researchers' aim is to clarify the strength nesses and the weaknesses of a real involvement of volunteers in cadastre.

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1. INTRODUCTION

Volunteered Geographic Information (VGI) was first introduced as a term by Goodchild (2007) who presented the Volunteered Geographic Information as an individual effort of amateurs who act voluntarily in GIS collection, editing and manipulation and their results may or may not be accurate. The main goal of the new phenomenon is the participation of the citizens. Everyone can be involved by collecting and uploading data or by editing entries and monitoring the results. Different terms are interlinked to it; User Generated Content, Crowdsourcing and Neogeography are only a few of them keeping in common the main philosophy. It is clear that a new era has risen in geographic information science by the citizens' involvement.

VGI techniques were first used for navigation purposes and leisure time. The cost of the conventional maps and the restrictions towards their use were the two main reasons which lead to that direction. However, the phenomenon was quickly extended in crisis management. Haiti earthquake and Hurricane Catrina are two representative examples of VGI mapping which meant supplies in medicine and food provided in short time. Pultar et al (2009) were among the first who noticed that dynamic GIS is an ideal tool for storing, analyzing and visualizing natural disasters such as hurricanes, wildfires, and earthquakes. Slum mapping and mapping of virgin areas was also developed with the aid of VGI. World Bank supported South Sudan mapping and numerous other applications which are carried out worldwide.

Land administration consists the basic tool for a proper land management; guarantee of ownership and security of tenure, fair taxation, security for credit, development of land markets, protection of land recourses, facilitation of State-owned land, reduction of land disputes, facilitation of rural land reform and improvement of urban planning (UNECE, 2005). It is remarkable that the number of megacities has risen from two in 1950 to twenty in 2005 while seventeen out of them are located in the world's less developed regions (Doytsher et al, 2010). More than 1.1 billion people live in slums which are located to unregistered parcels (McLaren, 2011). It is clear that the procedures should quicken and the cost should be in low levels with the involvement of individuals. As Adlington (2011) has underlined in East Central Asia region the land reform and land registration program has been completed by people without formal training in cadastral survey. The project was guided by surveyors who were open to help without being stuck to traditional methods and high levels of accuracy.

It is clear that society's needs for easy editable and inexpensive maps which can be produced in short time forced VGI in various fields. Is land management which mainly applies land information to land resources (UNECE, 2005) between the fields that can flourish with the

aid of VGI? Can legal principles and strict regulations be bypassed? Can sensitive personal information be trusted to volunteers? Is accuracy the most important part of a cadastral survey and how can be achieved? The research community has to identify its opportunities and its limits.

2. THE HELLENIC CADASTRE

2.1 Progress and Statistics

The Hellenic Cadastre started its operation in 1995. Although the project is in progress for 17 years, the results are quite disappointed concerning its process and its efficiency. It affects an area of 132,000 km^2 and 37,200,000 property rights approximately. However, only 6.4% of the total area has been completed until now which means that 8,400 km^2 and 6,800,000 property rights (which in percentage is 17%) have been officially recorded. The total cost of the project has reached 340 M€. Nowadays, 3,100 km^2 of the total area and 7,500,000 property rights approximately are under compilation. The cost the cadastral survey is estimated to 212 M€ -not including VAT– and the amount of the registered rights approaches 42 M€. The remaining 120,500 km^2 and 22,900,000 rights, concerning mainly rural areas, are still unregistered and the total cost of the project has not been defined.

2.2 Processes

The process of a cadastral record is summarized in the following steps. At first, the declarations of the property owners are submitted to the Cadastral Survey Offices and the registration of the declared rights is introduced in a digital database. Owners are also expected to recognize their properties on orthophotos, although the process is not characterized as successful in rural areas. Secondly, the interim cadastral tables and diagrams are formed based on the data that has been collected from the submitted declarations which means that an objection period starts by the suspension of the interim cadastral data at the Cadastral Survey Offices for a two-month period. Meanwhile, dispatch of extracts is sent to the right holders for their information and acceptance. The objections or applications for correction of a cadastral registration are submitted and forwarded to independent administrative committees, depending on the case, by whoever has a legal right. Then, the cadastral data is reformed and the final cadastral tables and diagrams are formed. These registrations are called Initial Registrations and they constitute the first registration in the Hellenic cadastre (Hellenic Cadastre, 2011).

2.3 Identified errors – Three representative examples

Identified errors concerning *the location, the shape* and *the boundaries* of land parcels have been recorded in various areas where cadastral survey has been completed. Errors are also noticed at the *records of the cadastral tables* where properties are recorded to belong to "*unknown owners*". Among the most important are those which have been mentioned at Lefkada, Corfu, Lesvos, Chios, Alonissos, Kefalonia and Zakinthos islands (Figure 1).

Figure 1: Areas with gross errors during cadastral survey

More precisely, there are four district categories of errors which affected the areas mentioned above:

1. Land parcels whose shape or boundaries need correction.
2. Land parcels which although they were declared by the owners within the declaration period they were not recorded by the contractor in the interim cadastral plans so were not recorded at all.
3. Land parcels which were registered into the interim cadastral plans as belonging to wrong cadastral units.
4. Land parcels which are located in adjacent cadastral units and are affected geometrically due to the correction of the boundaries of the unit which is under re-survey.

2.3.1 Lesvos Island

Lesvos is among the areas where gross errors have been recorded during the objection period. 42,205 land parcels have been registered until now and it is still unknown how many land parcels have been recorded wrongly as the cadastral survey is still under editing process. More than 2,500 objections have been submitted until now. It is estimated that if the percentage reaches 30% (aprox. 12,000 land parcels) the cadastral surveys will be repeated.

2.3.2 Chios Island

Chios is in a similar situation to Lesvos. 113,400 land parcels have been recorded until now while 1,970 errors have been mentioned. The policy is the same; if the recorded errors are more than 34,020 the procedure should be repeated.

2.3.3 Lefkada Island

Lefkada was affected in two different cadastral areas mainly; Tsoukalades and Haniotes village which are both mountainous and are located to the hinterland of the island. Tsoukalades was selected by the research team as the ideal area where the first practical experiment took place. (Basiouka & Potsiou, 2012). The research team came in contact to the local authorities of the village and asked for their participation. In their turn, asked among the property owners for volunteers. The process and the results are analyzed in the next chapter. It is estimated that 43,440 land parcels were recorded in total while 790 errors have been found until now.

The exact cost and time for the process to be repeated is not known yet as the objection period has not come to an end and the number of gross errors has not be identified in detail. However, the estimated time for the new cadastral survey to be declared approaches 1 year based on previous declarations and 2 years to be implemented based on the statistics.

2.4 VGI methodology – A tough estimation for an alternative process

A tough estimation of the VGI methodology as an alternative way to correct the gross errors indicated that the time and cost can be eliminated. According to the assumptions of the estimation, 10 volunteers should participate and record 15 parcels per day. The estimation was based on the results derived by the first practical experiment which was carried out by the research team in Lefkada island. The results showed that scattered areas in Chios can be resurveyed in 9 months and data editing can be concluded in 4 months. The whole process does not exceed 13 months in total in an island which seems to confront the greater problem. The errors in Lesvos can be corrected with the same process into 5 months. The cadastral surveys can be held with the aid of undergraduate students as team leaders. Similar role can be also kept by the local authorities which can provide the volunteers with the needed equipment and support on technical issues. It is clear that the whole process is based on what Goodchild (2008) mentioned in his research; “residents of a neighborhood are inherently experts in the local area”. The results are summarized at the Table 1.

Island	Number of Volunteers	Data Collection	Data Editing	Total Time
Lesvos	10	3 months	2 months	5 months
Chios	10	9 months	4 months	13 months
Lefkada	10	3 months	2 months	5 months

Table 1: VGI methodology - time needed

The main idea of the VGI methodology was adopted by OpenStreetMap which is the first free, editable and not restricted by copyrights map which success is based on volunteers who collect and edit the data. It’s operation is simplified in 5 main steps which can be carried out by the Volunteers; gathering and uploading data, editing maps and data, rendering maps.

The first step of the process should be done at the field with the aid of orthophotos as draft maps and handheld GPS. A hierarchical pyramid of volunteers which will be constituted by students, local authorities and the local residents can take action. The experience indicated

that the very first identification of the parcels on orthophotos at the cadastral office is unsuccessful at rural areas. Thus, the process can be done simultaneously with the data collection at the field.

The second step includes data uploading by volunteers and the third includes map editing. The local residents will be able to edit the collected nodes and create polygons by using open source systems.

The attribute data which will accompany the geographical data will be registered by the volunteers at the forth step of the procedure and the result will be shown at the last step.

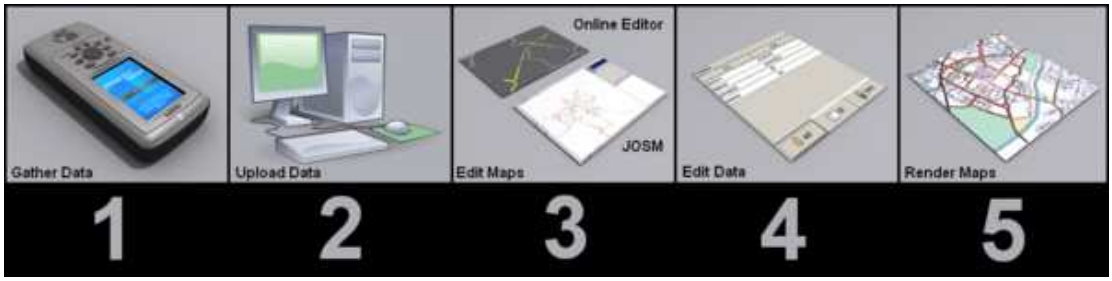


Figure 2: OpenStreetMap process (source: OpenStreetMap, 2010)

3. THE PRACTICAL EXPERIMENTS – CROWD SOURCING IN CADASTRE

The two practical experiments were carried out in different time periods and areas covering different methodologies of VGI. The aim of the experiments was to simplify the processes needed for a cadastral survey, the time and the cost. Although the concept behind the experiments was the same, the process was different. The first experiment was carried out in a rural area at Lefkada island and the second one in an urban area at the city of Athens. The results of the first practical experiment were presented at the FIG Commission 3 Workshop and were published. (Basiouka & Potsiou, 2012).

3.1 The test areas

The first experiment was carried out in Lefkada island, an island of the Ionian Sea. It lies between the islands of Corfu and Kefalonia. It is very close to the shores of the western mainland of Greece covering an area of 302.5 km^2 and is the fourth in size in the Ioanian islands complex, with a population of 23,000 people. The community of Tsoukalades is one among seven communities which apart the municipality of Lefkada. Tsoukalades village is located in 220 meters elevation in the north-west part of the island and it has 430 habitants according to the last census.
The second experiment was carried out in the city of Athens at the area of Kallithea, which is expanded between Athens and Faliro Bay. Municipality of Kallithea is an urban area at the south east part of Athens and it has more than 200,000 habitants.

Figure 3: The test areas; Lefkada island (left) and Kallithea (right).

The first area is under cadastral survey for more than 12 years due to discrepancies and the specific cadastral unit was been resurveyed four times. The cadastral survey at the second area of interest which is an urban area with well defined boundaries has not yet concluded. The first phase has been concluded by 2008 but the second one has not started yet.

3.2 The experiments

3.2.1 Rural area – Lefkada island

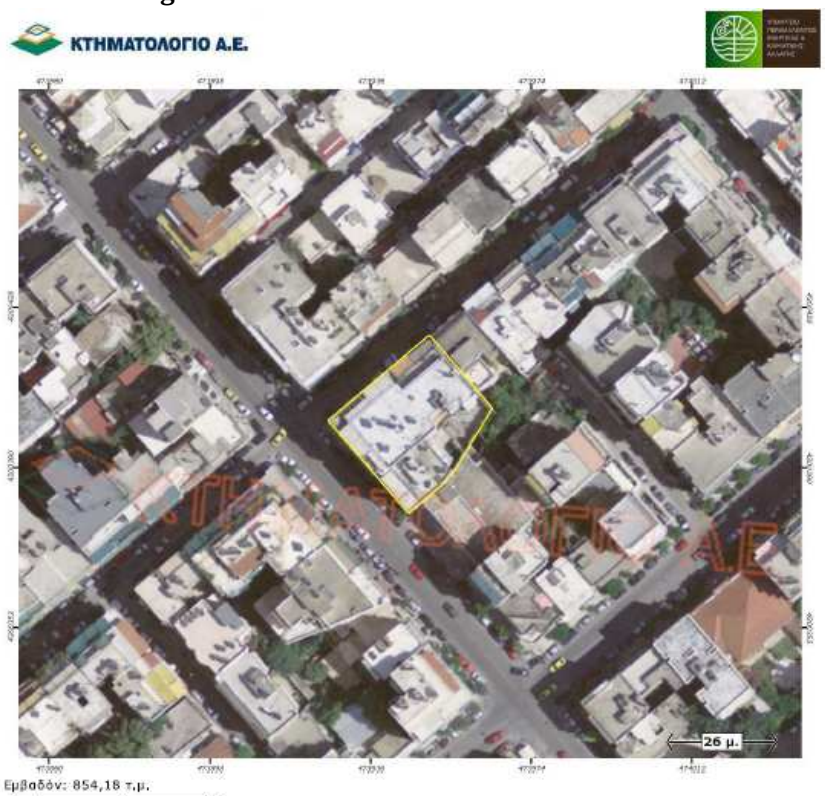
The first experiment took place at Lefkada island during a summer weekend of 2011. Fifteen volunteers participated and 19 land parcels were traced with the aid of 3 experts and a handheld GPS. The area of interest was a rural one filled with olive trees and cultivated areas. The parcels were chosen randomly so that the sample will be representative and the volunteers collected the tracks of their boundaries with the aid of a hand held GPS (figure 4). The data editing was done aftermath at the laboratory by the research team.

The results indicated that the location and shape of all land parcels based on the last cadastral survey are correctly defined and the majority of the land parcels' area size is sufficiently defined and within the requirements posed by the KTIMATOLOGIO SA. Only eight of the hundred measured nodes have coordinate deviations greater than 5m while the area size of seven out of the nineteen land parcels (37%) differentiated from the correct size.

The main weaknesses of the process were focused on the minor obstacles of GPS signal due to the trees and the difficulties that some elderly volunteers faced with the use of the GPS.

The main strength nesses were focused on the great participation of volunteers, the lack of disputes and their easiness to answer sensitive personal questions.

Figure 4: The Volunteers at the Rural Area



Εμβαδόν: 854,18 τ.μ.

Α/Α	X	Y
0	473925,95	4200401,16
1	473944,87	4200379,20
2	473954,53	4200387,13
3	473964,85	4200404,07
4	473949,90	4200421,40

Figure 5: The interim cadastral map derived online

3.2.2 Urban area – Kallithea

The second test took place at Kallithea Municipality, close to the centre of Athens, in a one day application during the winter 2012. 9 volunteers were participated, 7 land parcels were traced, 1 handheld GPS and 1 ipad were used. The results using the handheld GPS were disappointed comparing to the technical specifications required by the official mapping agent. Due to signal obstacles, the accuracy was not satisfactory so a different approach was applied. The land parcels were drawn online on orthophotos provided by KTIMATOLOGIO with the aid of the ipad (figure 6). The volunteers used the online web system which is supported by the official mapping agent (KTIMATOLOGIO SA) and created the interim cadastral map extract of their building on orthophotos (figure 5). The orthophotos which are provided by the system were received between 2007 – 2009 and their accuracy approaches 20 cm in urban areas and 50 cm in rural areas. Each extract was accompanied by parcel's coordinates and total area which could be used comparatively in a further step of the process as a control. The whole process was straightforward and quick offering the opportunity to the local residents to conclude the process from data editing to map rendering. The results were in high levels of accuracy.

Figure 6: The volunteers at the urban area

3.3 The volunteers

The sample of volunteers varied a lot between the two experiments. In the first experiment took part elderly people with no special educational background. In the second experiment took part young students, all under 25 who were familiar to new technologies (figure 6). All were local residents and property owners in the areas of interest based on the perception that no one knows the local area better than the residents.

Their motivations were summarized in four main categories: speed up the procedures; eliminate the costs; unblock the market in the areas with errors in cadastral survey; participate as active cells of the society. As Laarakker (2011) first mentioned, their

motivations are not altruistic. They are motivated by their need for an updated land administrative system which will guarantee their ownership.

5. CONCLUSIONS

The methodology that applied, offered satisfactory results in both cases and within the technical specifications required by KTIMATOLOGIO. The participation was enormous and time was eliminated dramatically without taking into account cost. The volunteers were willing to participate, answer the questions and get involved to the experiment. The involvement of local authorities in the first experiment and undergraduate students in the second one guarantee the process and help to overcome technical issues.

It is clear that the process is not regulated yet but the very first steps have already been done towards this direction. Handheld GPS will be soon replaced by smartphones and new applications will be created to serve these needs. It is obvious that, the volunteers will be get involved in the next steps of VGI such as uploading and editing of data so that the final map to be produced by them.

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