

THE NEED FOR 3D CADASTRE IN KOSOVO

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Summary

The aim of this article is to analyze how the cadastral system was developed in Kosovo historically, to examine methodically in which level of development is it and to investigate potential solutions in 3D cadastre development comparing other countries success with our own achievement. The author will describe 3D elements of cadastral data. There is a simple example of how 3D cadastre should look like. Finally a draft roadmap for 3D cadastre establishment will be proposed.

This article is prepared based based mostly on literature review and the proposals deriving within this paper express the opinion of the author based on the conclusions from Kosovo conditions comparing to other countries developments.

Key words: 3D cadastre, 3D GIS, Building Cadastre, Property, Legal Framework, Property Registration

1. INTRODUCTION

Cadastre as a system has evaluated from traditional “paper and pen” based into a digital and GIS oriented one. Kosovo as a young country during the last fifteen years developed a quite modern cadastral system and has done huge steps forward in European standards application. But many countries nowadays are facing with new challenges, focusing towards innovative ways of new 3D cadastre solutions. Many software development enterprises are

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performing 3D application modules and researches regarding legal framework are taking place throughout the world.

Every property has three dimensions in the real world but in the existing cadastral data they are mostly sketched in two dimensions.

Kosovo's cadastral system includes some 3D elements such as the number of floors for the buildings in Building Cadastre registers. But nowadays the trends throughout the world are oriented towards 3D cadastre. Kosovo as a country with European perspective needs to focus its attempts in legal and technical researches towards 3D cadastre.

Time considered as the fourth dimension plays an important role in spatial and cadastral data. 3D GIS, without taking time in consideration as the fourth dimension has much in common with a photograph since it represents the situation at a particular time (Heywood, Cornelius and Carver, 2012). Therefore a dynamic, 4D cadastre must come into consideration in the near future.

2. BACKGROUND

Property registration is done through centuries mostly for the purpose of taxation but beside that there are the owners who benefit by registering their properties and this way securing the ownership. In most of the countries the property registration and the mapping for this purpose is done through cadastral systems. The techniques used for property registration and cadastral mapping were simple, manual and 2D oriented till recently. No property on the real world has 2D dimensions even the land parcels have the 3rd dimension which is the height above the certain comparative surface. Usually geodetic heights are applied.

Kosovo as the youngest country in Europe has a history in cadastral systems. The biggest achievement of Kosovo in the field of cadastre and property registration came after the war of 1998/99 when the attempts were oriented on digital cadastral system. One of the aims was to fulfill the recommendation from the "Cadastre 2014" as a vision for the future of the cadastral systems throughout the world (Kaufmann and Steudler, 1998).

Before 1999 the cadastral data were systemized into two kind of different data: graphical data – consist of paper maps and sketches and textual data-

consist of land books or registers. After 1999 and the process is still ongoing, the cadastral data were digitized.

The Immovable Property Right Register developed from the Kosovo Cadastral Agency was established earlier compared to the “graphical data” segment. It has shown good performance and is maintained in daily basis from Municipal Cadastral Offices (MCOs). The graphical data were also scanned and digitized but the maintenance of this segment is still not working properly. Real estate properties (thereafter properties) are defined and described as RRR (Rights + Restrictions + Responsibilities) (Mattson, 2009). Within Kosovo’s cadastral system the list of cadastral units includes not only the land parcels but buildings, part of the buildings and utilities as well (Law on cadastre no. 04-L/013). Till now Kosovo managed to develop and establish a 2D digital cadastral system and nowadays the process of merging two of its main components (textual data segment and graphical data segment) is ongoing. Special software called Cadastral Map is developed especially for this purpose (Kosovo Cadastral Agency, 2014). Steps forward are done also towards establishment of National Spatial Data Infrastructure (NSDI) and for few years now a national geoportal is running (www.geoportal.rks-gov.net).

Undoubtedly we can say that in Kosovo right now is ongoing a quite organized and functional digital cadastral system.

In general it is accepted that the owner of a land parcel owns not only the thin layer of the land cover but the space below the surface and the space above the surface as well. Even that cadastral data consists of the 2D land parcels in principle the owners are entitled to a 3D space (Stoter, 2004). Examples from different country legal frameworks show that the ownership is identified as the extent of the property from the subsurface to the air space. Typically those situations are describes as “from-heaven-to-hell” (Ivan and Ossko, 2015).

Not only buildings but even land parcels in many situations need to be sketched in 3D. Development of new technologies has provided the possibility for 3D cadastre establishment. GIS in general offers great opportunities for 3D mapping. Examples of 3D city modeling can be found online and 3D software modules are developed from almost all the software providers. But we have to know to distinguish between 3D city modelling and 3D cadastre. While 3D city modeling focuses on a 3D view of the

buildings and other spatial objects; 3D cadastre represents additionally the legal framework, rights of ownership/use. Therefore we can say that cadastre has not changed in its content there are only new techniques applied for a better way of property description.

The first attempts towards 3D cadastre were done after the Second World War. Nowadays researches are undertaken in around 30 countries (Rajabifard, 2014).

The best example is probably coming from Israel as one of the pioneers towards 3D cadastre.

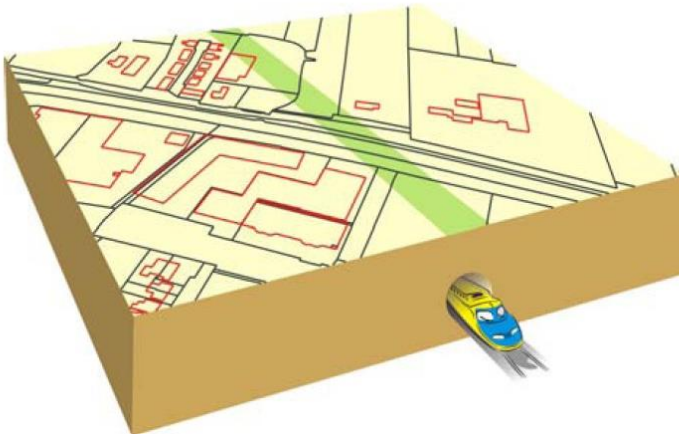


Fig.1.Example of registering 3D situation using 2D techniques (Stoter, 2004)

European countries are also doing a good job on the field. In the list of European countries we can list countries such as: Sweden, Norway, The Netherland and Denmark. Good examples can be found even in Australia (Stoter, 2004).

Despite legal framework problems the beginning of 3D cadastre was faced with problems in 3D modeling. Classic GIS systems and certain software have tried to give the basis for 3D mapping. Using regular geometric figures was the first attempt for 3D mapping and 3D visualization but soon it was realized that this was not enough (Erba, 2012).

The targeted features usually are tunnels, bridges, malls and condominiums. From this we can see that: no country in the world is trying to cover the whole country's area; instead they are trying to identify areas with priority. This gives the opportunity to test the system and do the necessary

corrections and improvements in the system before huge campaigns are undertaken.

We have to be clear that 3D cadastre is not 3D city modelling. **“3D cadastre is a way of registering properties including all attributes of the properties, rights, restrictions and responsibilities and in combination with 3D techniques makes possible the visualization of 3D situations”**. Therefore we can say: **“3D city modelling is a valuable tool for 3D cadastre which helps 3D modelling of 3D situations”**.

3. IMPLEMENTATION PLAN

3D cadastre is a quite wide topic and covers every object that is possible to be registered in the cadastre. Buildings with their complexity and also underground infrastructure can be considered the most problematic part and which has priority in 3D cadastre.

Kosovo has its own problems and complex areas where 3D cadastre is needed. The aim of 3D cadastre is the clarification of real world situations not only by in 3D the cadastral units but also by solving legal disputes and registering property rights.

We are taking as example Prishtina, the capital of Kosovo. Prishtina now is facing an extremely increasing number of people who have migrated from other areas of Kosovo. Despite the last registration of population in Kosovo it is evaluated that the number of people now is around 500 000 or 300 000 more than it had before 1999 (Koha, 2012). Table below shows the number of people in Prishtina according to some organizations acting in Kosovo and including last registration which is doubted even from the Prishtina municipality. According to the final report of “Building Cadastre Construction” in the urban area of Prishtina the number of condominiums is 976 and number of apartments is 24606 (Final Report on BCC, 2011).

Year	1953	1981	1991	1998	2002	2012
No of People	24000	210040	205093	225388	545477	198214
Institution	SAK	SAK	SAK	/	OSCE	SAK

Table 1. Number of people in Prishtina (source: <https://ask.rks-gov.net>)

We have to state that the number of condominiums increased dramatically during the last four years.

Year	1970	2000	2013
Land Use (%)			
Urban Area	24.05	47.81	64.71
Agriculture	67.77	45.7	29.42
Forest area	7.71	6.24	5.67
Water area	0.48	0.25	0.19

Table 2. Land use in Prishtina (Source: Isufi F. and Murseli R. 2014)

The land use in Prishtina shows that the percentage of urban area is growing with fast steps. That is obvious from Table 2.

Therefore it is obvious that such number of condominiums is causing many problems in traffic lines, urban planning and property rights registration. Same situations can be found even in other cities of Kosovo.

Despite the condominiums complex situations in the field can be found in tunnels, bridges overpasses and underpasses. Complex situations can be considered even malls, underground constructions and especially underground and above surface utilities.

“Trepça” mining resort is famous and represents one of the biggest mining resorts in Europe and during the 1980s it represented 70% of the mineral wealth of Yugoslavia (www.trepca-akp.com). “Trepça” mines and tunnels are another example for the need of 3D cadastre application.

Considering 3D data needed for development of 3D cadastre we can say that Kosovo already has some valuable data. In the list of the data, owned by Kosovo Cadastral Agency and which have 3D elements we can mention:

- Digital topographic maps – which can be used quite well in 3D land parcel presentation,
- Building Cadastre sketches and registers – which represents a combination of registers with the number of floors for condominiums, 2D measured footprints for the buildings and hand-drawn sketches where the apartment entrances and common areas are identified,

- Underground Utility Cadastre – which is also a combination of measured utility lines and sketches drawn for the pits where those lines are passing.

The situation shown on the picture below is a combination of tunnels, stores, condominiums and public areas. From my point of view it presents one of the most complex examples in Kosovo.



Fig. 2. An example where 3D cadastre is needed (Dardania, Prishtina)

Underground utilities represent another complex example of cadastral unit which is almost not possible to be represented in 2D maps. The lines drawn on the 2D maps and representing the utility lines are very hard to be understood especially in situations where are many utilities above each other.

There have been some attempts through some projects in Prishtina municipality to establish underground cadastre using 2D techniques but from my point of view the project started before doing the necessary analysis about the situation on the field. There are problems from technical point of

view and especially the legal side is the most problematic one. The company which was doing the pilot project, due to lack of budget and unwillingness of the responsible body to develop 3D module introduced a simple sketch in order to give some idea of the real situation (Final report on underground cadastre establishment project). Picture 4 shows an example of such situation where underground utilities are represented in 3D using 2D techniques.

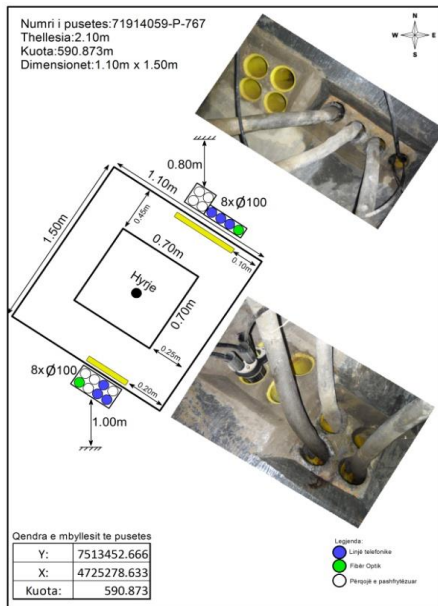
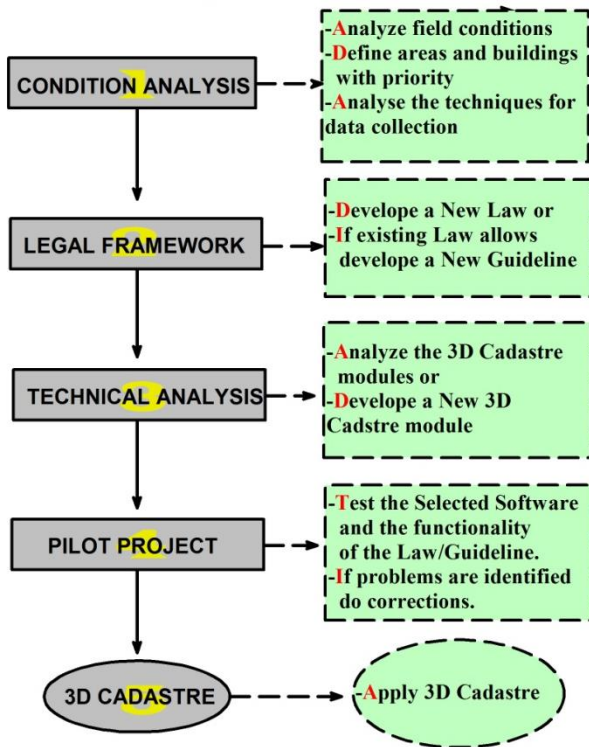


Fig. 3. Underground utilities and vine cellars as an example where 3D cadastre application is needed.

Above I have listed and explained some of the situations in Kosovo where 3D cadastre is needed. I have to point out that what I expressed within this article represents only a short list of the situations which brings Kosovo in-front-of the situation to start researches and decisions towards 3D cadastre.

New developments many times in practice are accompanied with a lot of mistakes and problems which can lead huge projects toward fail. Therefore before starting something that is new many detailed analysis should be performed by the responsible authorities.

Analysis should take place following steps described within a roadmap which needs to be developed by a responsible body. A simple roadmap is the one proposed within this article and described in the chart below.



The first step towards 3D cadastre is **Condition Analysis** the responsible bodies during this stage should focus on the feasibility analysis, cost and benefit and the strategy of implementation. During this stage is suggested to:

- Analyse the field conditions and the country characteristics and adopt guidelines according to the country needs considering cultural aspects as well.

Fig.4. Roadmap to 3D Cadastre.

Many times importing techniques and guidelines from some country's experience is the worst thing to do. It brings bad and complicated results.

- Researchers from around the world agree that is not necessary to try covering the whole area of a country by 3D cadastre registration. Therefore it is wise in the beginning to focus only in high-rise-buildings (Kalantari and Rajabifard, 2014).
- Collecting data from the field is another issued that must be well analyzed. Data accuracy has an important role in cadastral system. LiDAR data can be a good solution to be applied in buildings. But it is the most expensive method of course. Belongs to the responsible authorities to analyze the needs for accuracy and decide for the techniques that must be applied.

LiDAR data (Light Detection and Ranging) also known as 3D laser scanning is a new and modern technology which allows the users to capture millions of points, known as point clouds, fast and accurately. This technique makes possible to view the 3D world virtually (Khoo, Low and Hao, 2014). The laser scanning allows terrestrial and airborne scanning and this makes possible to cover almost all the possible buildings in the field. Filters can be applied in order to capture the needed data and avoid what is not necessary. When the data are selected, the users can do building modeling and virtualization using any of the today's market software (Vögtle and Steinle, 2000).

4. LEGAL FRAMEWORK

Legal framework is the step which can lead to success or fail. Therefore during the legal framework preparation deep analysis should be performed. Examples from the world show that in many countries the law allowed to do registration of properties in 3 dimensions by using 2D techniques. One good example is coming from Australia precisely from Melbourne where you may find a routine of developing 3D cadastre using 2D techniques (Kalantari and Rajabifard, 2014). It is of high importance to do analysis if the existing law can be applied in 3D cadastre and fulfilled only with a guideline or it is needed a new law. Kosovo aims to join European Union in the coming years. Therefore the legal framework dealing with 3D cadastre should be harmonized with international standards. ISO 19152 (Land Administration Domain Model) fits properly with 3D cadastre structure development. Example coming from Israel shows in practice how this ISO standard is harmonized with Israel's legal framework and can be a good example to be followed (Felus, Barzani, Caine, Blumkine and Oosterom, 2014).

The third step on the given proposal for the roadmap is **technical analysis**. 3D cadastre is depended entirely on 3D GIS. Visualization of 3D buildings allows the situation from the field to be obvious and clear from the office. Software development enterprises today offer a wide range of choices for the software selection. Open source software applications are available and that

can be a solution as well. ESRI and Intergraph products probably dominate the world market today. Therefore those products also offer the best solutions for 3D GIS for the moment. Those products also offer a variety of applications with the possibility of applying in 3D cadastre. Visualization in 3D and the attribute tables (databases) make the products of ESRI and Intergraph more appropriate than Autodesk products. Responsible authorities should perform analysis if any of the existing GIS modules fulfill the needs and criteria to be adopted in 3D cadastre. One suggestion can be derived from the nowadays technology developments and that is BIM (**B**uilding **I**nformation **M**odeling). Definition of BIM says: *“Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition”* (www.nationalbimstandard.org). Applying BIM despite many other priorities is also a good solution for attempt orientation towards a dynamic 4D cadastre directly instead of just stopping at 3D. Mapping and registering what you have in a certain area is not always enough. While the time passes changes happen on the field. What was the situation before the actual situation within a certain area is also important. Considering time as the 4th dimension many countries have focus now in the 4D cadastre as the requirement of the time (Vučić, Roić and Markovinović, 2014). During this stage international situations should be analysed before developing 3D cadastre.

5. PILOT PROJECT

Pilot project performing is something to be taken into consideration. The adopted guideline and software selection can be worthless if they do not work properly in practice. It is preferred to test installed framework and analyze the performance. If problems are detected than authorities have the chance to do the needed corrections. Those corrections can be in guidelines or specifications and even in the software. It is important to point out that such kind of pilot project can take from one to two years or even three of performance analysis. The testing time period made me suggest it as one of the steps toward 3D cadastre. 3D cadastre should be start running after the four previous steps are fulfilled. It is hard to say from the date of the first

step starts how long it will take to finalize the fifth one. But the body responsible for the task should develop a time table and put the goals they want to achieve.

6. CASE STUDY

Within a simple example I will try to show how a 3D cadastre can visualize real world situations. This example derives from a case of dispute between two brothers about the building they inherited. This example will be limited only in the technical aspects and the way how this situation is displayed in 3D.

The small building have been divided into two apartments owned each from one of the owners and a common space which consists of the stairs and areas connected to it. The basement also is divided into two areas for each of the owners and a common area close to entrance (Fig. 5). Each of the colors from the picture shows the properties owned by each of the owners and the common area.

The idea of this example is to show the importance of 3D cadastre. Even in such small disputes it can play an important role.

The situation from the 2D plans looks as can be seen in the picture 5. The owners have done some sketches showing the way their property is divided (Red color represents the property of owner 1, white color represents the color of owner 2 and the orange color represent common area, the roof is used as warehouse and it is a common property).

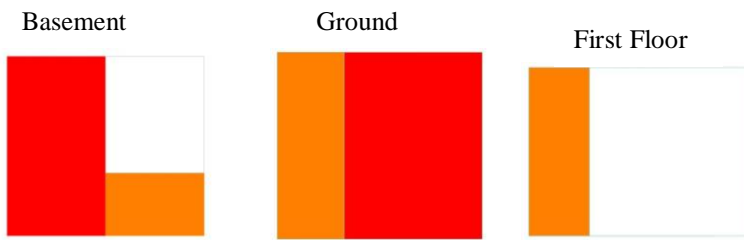


Fig. 5. 2D plans for a property

After application of 3D cadastre this situation could have this view (Red color represents the property of owner 1, white color represents the color of

owner 2 and the brown color represent common area, the roof is used as warehouse and it is a common property (Fig. 6).

Only by clicking into one of the separated parts on the building an attribute table will show and we can add all the data required for a property.



Fig. 6. A simple case of 3D Cadastre application

7. CONCLUSIONS AND OUTLOOK

Within this article the author explained a part of the mirror which stands in-front-of development towards 3D cadastre in the world and the actual situation regarding this topic in Kosovo. Some of the ideas introduced within this paper are well accepted from scientist and represented within their work in different publications but those dealing especially with Kosovo reflects the author's own outlook and not necessary represent the view from Kosovo government or any other responsible body.

Therefore, as a conclusion I can say that: it is important to start legal framework analysis and researches towards 3D cadastre in order to follow the steps and trends of the today's cadastral systems, there are many areas and objects in Kosovo which can be subject of 3D cadastre and there are also priority areas where 3D cadastre is needed immediately, 3D cadastre represents a new development which will lead towards better ownership security and benefits from 3D cadastre will have an impact in country economic standards by using the data in tax collection, property valuation and loan providing system from the banks.

This article aims to contribute to the first step toward local cadastral experts awareness increase about the new challenges in international context regarding 3D cadastre.

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