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GIS FACILITIES FOR THE AUTOMATION OF CADASTRAL DOCUMENTATIONS

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Abstract

This paper highlights a few ideas which lead to a significantly higher efficiency with regards to cadastral documentations. Each legislation change in the field of cadaster brings new challenges for a geodetic engineer. Although many software packages are available which partially automate the generation of various appendices of cadastral documentations, never was there an attempt to fully automate the generation of a documentation. Taking into consideration the facilities offered by GIS tools especially, an attempt was made to make a major reduction of the time necessary to create a documentation. For the appendices which involve both numerical and alpha-numerical inputs, a very cheap and simple solution was proposed - Microsoft Excel; meanwhile, for the graphical parts of the documentation, which are the most important, an alternative which uses AutoCAD Civil 3D and ArcGIS was proposed. The method was tested on a sample of 47 cadastral documentations, which highlighted that the time involved in the completion of a cadastral documentation was reduced by a factor of 8.

Key words: *cadastral documentation, GIS, automation.*

INTRODUCTION

All of us are feeling the discomfort caused by the speed at which our activities are carried out. In the conditions, it seems there is never enough time to successfully accomplish everything we aim for. In addition, the recent legislation change is added (***, ANCPI, 2023), specifically the publishing of Executive Order 600 which brings into regulation the way cadastral documentations are created. In this context, there is a need for a better organisation of the geodetic engineer's activity and an increased time efficiently for completing cadastral documentations. Such proposals have been made previously (Tereşneu & Vasilescu, 2013), but these were aimed at past legislation and were only focused on the partial automation of the generation of cadastral documentations.

Today, a very high degree of automation of all cadastral operations is achieved, from field surveys (using total stations and GNSS equipment) to steps involving office work (both in terms of numerical processing of data and creation of graphical documents - Boş and Iacobescu, 2007; Boş et al., 2015; Tămâioagă & Tămâioagă, 2007).

Additionally, previous studies have investigated achieving an inter-operability between the cadastral system and other systems dealing with land administration (like tax records, land administration, issuing construction approval documents, legalisation of building and so on) and which would also benefit from a high degree of automation (Sladic et al., 2020).

Another area in which automation has seen significant use is that which aims to monitor urban sprawl, both horizontally and vertically. Complex mechanisms are required not only to monitor but also control the degree to which established urban development reglementations are followed (Ghawana et al., 2020).

In this context, we can also mention some other challenges from the field of automation of cadastral operations, with regards to the automatic identification of land parcel boundaries, both in 2D and 3D (Larsson et al., 2020).

Since this automation process involves working data stored on-line, other papers were taken into account which, although used other kinds of data, still offered the necessary theoretical basis for the correct approach of the current problem (Díaz-Hormazábal et al., 2020).

Previous papers also looked at solving the graphical elements of the cadastral

documentation, which are the most important and difficult to complete (Tereşneu et al., 2013).
Also, there are numerous software packages which can aid and facilitate the automation of various steps in the creation of cadastral documentations (Tereşneu et al., 2009), or the automation of acquiring necessary data from the immediate vicinity (Tereşneu et al., 2016). In addition, this paper also uses techniques specific to photogrammetry and remote sensing (Herbei et al., 2021; Vorovencii 2014a; 2014b; 2015a; 2015b; 2017), as each cadastral land plot is interconnected with other land plots, with which it always has a common arc.
Not only that, but similar approaches from other countries were also taken into account (Mataraci, 2005), which aimed and ultimately managed to create cadastral land records for the whole national territory.

MATERIALS AND METHODS

The materials used for this study are a:

- Dell Latitude 5411 laptop with Intel(R) Core(TM) i7-10850H CPU @ 2.70GHz 2.71 GHz, 16GB RAM, for the processing of all numerical and graphical data;
- the Microsoft Office package, especially Microsoft Excel, which was used to automate the input of text and numerical data into the appendices, but also to reunite all appendices in a single file (using VBA facilities);
- AutoCAD Civil 3D which was used to import field survey data and for the automatic creation of polylines for each individual land parcel;
- The E-terra platform for the verification of adjaciencies of studied land parcels;
- ArcGis, which was used for automating the generation of delimitation plans for the land parcels.

In terms of research methods, various techniques of applied informatics, computer programming (Tereşneu & Ionescu, 2019; Tereşneu & Ionescu, 2016) and GIS-specific methods (spatial analysis, VBA code-sequences etc.) were used (Tereşneu & Ionescu, 2014; Tamaş & Tereşneu, 2010).

RESULTS AND DISCUSSIONS

As is well known, a cadastral documentation requires the completion of appendices 13, 14, 15 and 16. The first three appendices require numerical and alpha-numerical data which are specific for each cadastral documentation.
With regards to appendix no. 13, a template in which the specific data will be input has been created in an Excel worksheet (Figure 1).

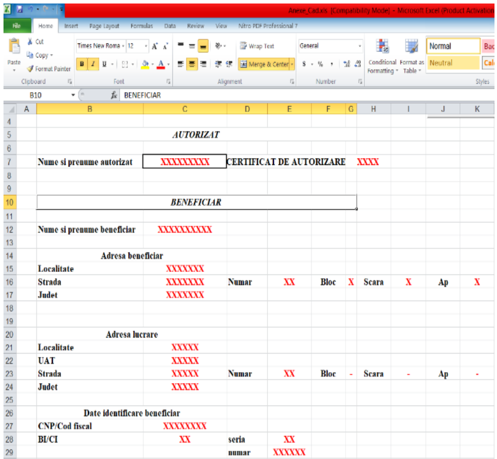

Figure 1. Input of general data

In another worksheet of the previously created Excel file (Figure 2), a template of appendix 13 is introduced, which will take the required data from the previous sheet. This can be done by a VBA code sequence which add into sheet 2 all necessary data from sheet 1 (Figure 3).
Appendix 14 is completed in a similar manner, by taking necessary data from the first sheet of the Excel registry and inserting it into the appropriate worksheet (Figure 4), also by using a VBA code sequence.
With regards to appendix no. 15 which is the technical report of the documentation, besides general information which is inserted into a distinct worksheet of the Excel registry, two types of data will be acquired from the first sheet (Figure 5): simple data and data specific to the technical report (the motivation for the documentation, data regarding adjacent parcels, data regarding old land writs of the parcel, data regarding the land survey and so on).

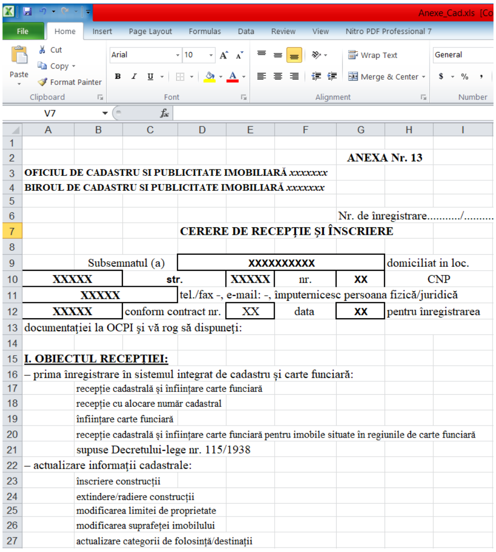

Figure 2. Template for appendix 13

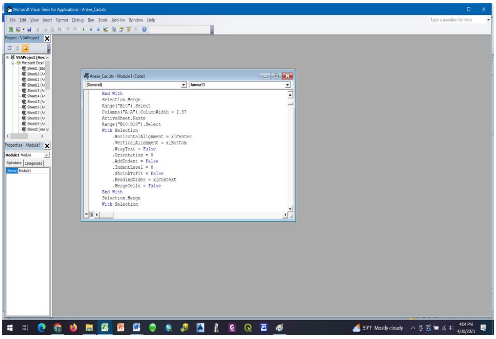

Figure 3. VBA sequence for the generation of appendix 13

The more delicate part is automating the generation of appendix 16, which is the plan of delimitation for the land parcel. This is done in multiple steps:

- The AutoCAD step; here points are imported from the *.txt file of the land survey, which was previously converted to *.csv. A crosspiece is created which automatically connects (by code) all points that define the parcel's boundary (Figure 6).

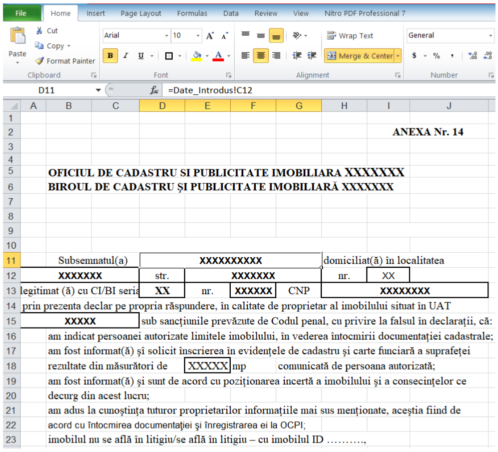

Figure 4. Template for appendix 14

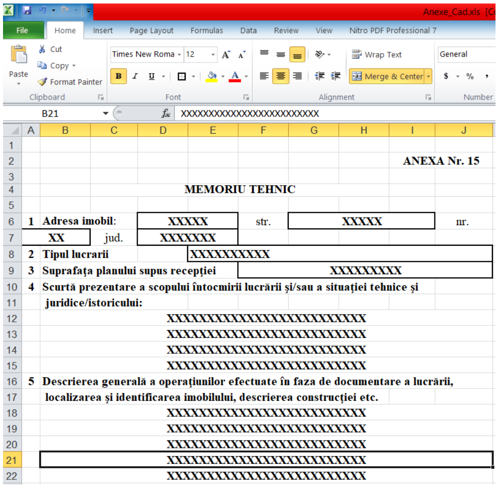

Figure 5. Template for appendix 15

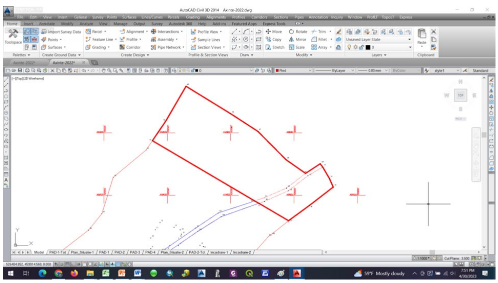

Figure 6. Automatic generation of parcel boundary

- The E-Terra step; on the E-Terra platform, a first registration job is created for the municipality where the land parcel is located and its polyline is imported. Plot adjacencies are verified; if adjacent parcels are already registered in the integrated system of cadastre and land records, their cadastral ID numbers (Figure 7) are automatically retrieved, with appropriate labels being placed on the corresponding sides at 0.5 cm (Figure 8). Also in this step, a general verification is done regarding possible boundary overlaps or gaps due to parcel misalignment. From the platform, data of interest is export in *.shp format: polygons of adjacent plot boundaries and neighboring numbers applied on adjacency arcs.
- The ArcGIS step; the AutoCAD and everything exported from E-terra is imported into ArcMap (Figure 9). Here, overlaps/gaps are checked using a VBA code sequence. The script takes into account accepted tolerances intra-urban/extra urban areas and the degree of closeness/overlap with adjacent plots. If the appropriate conditions are met, point coordinates are taken from adjacent land plots to modify the boundary of the current parcel. In this case, a warning message is shown in which the distances between polylines and the areas of overlaps/gaps are presented. Significant problems are found when there are certain spaces between the surveyed parcel and other parcels recorded in E-Terra and the coordinates of neighbouring points cannot be assumed because the land area calculated from the survey would be changed. Since this is a relatively complicated issue, it is beyond the scope of this paper. Finally, the North symbol, the coordinate grid and the tables specific to appendix 16 are added and then the appendix (Figure 10) is exported to a *.pdf file.

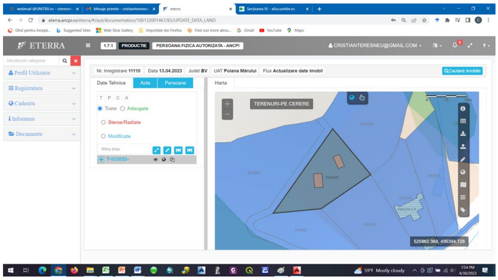

Figure 7. Studying adjacencies in E-Terra

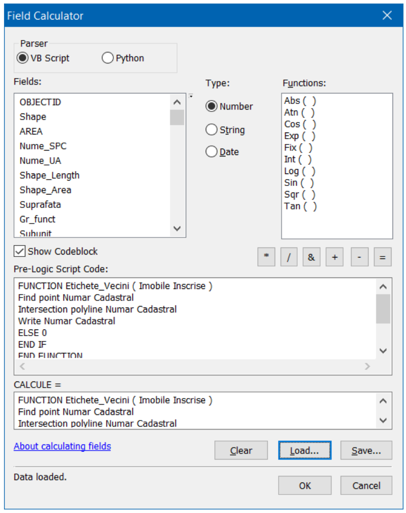

Figure 8. Automatic labelling of adjacent parcels

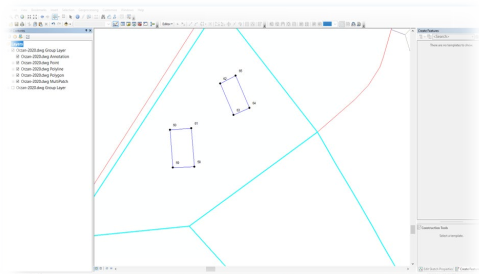

Figure 9. Importing of data into ArcMap

The last step is joining all appendices into a new worksheet of the Excel registry (Figure 11).

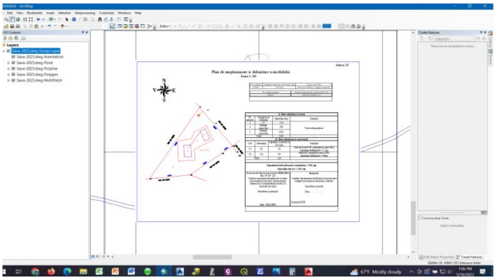

Figure 10. Plan of delimitation (PAD) generation in ArcMap.

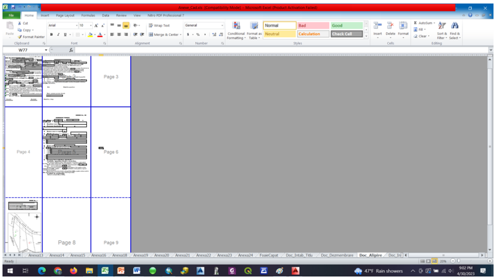

Figure 11. Completion of the cadastral documentation

CONCLUSIONS

The application of this method on 47 test cases lead to very good results both in terms of time efficiency and the correctness with which documentations were completed. With regards to time, a maximum efficiency was recorded, as working time has been shortened by a factor of 8. All 47 documentations were done by the same person in both approaches, with the effective working time being shorter in the automated approach by a factor of 7.6-8.1. Taking into account external factors (especially the degree of tiredness), we can assume that the recorded time economy is 8 times larger than in the classical approach (also considering the time necessary for an additional verification).

With regards to the correctness of the completed documentations, it has been found that this approach eliminates numerous possibilities of incorrect data input.

Evidently, the proposed approach can be improved, especially with regards to the automation of appendix 16. Besides the E-Terra step which is mandatory to be carried out under strict observation by the geodetic engineer, all other steps can be fully automated, with the most pressing issue being that of linking all pieces that are part of the same documentation.

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