

ABSTRACT
RESEARCH ON INFORMATISATION OF PROPERTY REGISTRATION IN THE
LAND BOOK

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Currently, the national cadastre is designed as an information system of all land and real estate, regardless of their destination. The cadastral works are organized on administrative territories and include a set of cadastral operations, which ensure the identification, delimitation, measurement and evaluation of buildings, which are identified both on the ground and on the cadastral plans.

The general cadastre, as regulated today, involves, in addition to conducting field measurements, the registration of all data that define the buildings both in numerical and graphic form, kept in registers and cadastral plans. With the introduction and completion of the general or systematic cadastre, access to real estate information is ensured either from public or private patrimony of all individuals, legal entities, or state institutions, thus ensuring the guarantee of property provided by the constitution.

The main object of the cadaster, either sporadic, general or systematic, it is formed by the real estate, which aims to know and inventory the following basic data:

- the real estate, consisting of one or more plots, with or without constructions, having a certain destination, category of use, surface and quality of the land or construction;
- the owner of the real estate, identified according to the documents and according to the legal situation regarding the quality on the basis of which he owns the real estate.

The inventory, the collection of all the characteristic details and at the same time their integration in an information system is a challenge for the specialists in the field of cadastre. The collection of data through different means, legislative changes, but also different methods of integrating these elements in the electronic database of the National Agency for Cadastre and Real Estate Advertising, through the related territorial offices, led to numerous discrepancies in the database.

This doctoral thesis is structured on seven chapters, totaling 142 pages and containing 109 figures, 5 tables and 81 bibliographic references.

In Chapter 1, entitled "Generalities, regarding the registrations in the Land Book", are presented general aspects regarding the evolution in time of the works and integration methods of the cadastral data, as well as of the current state regarding the registrations in the land book.

Over time, the National Agency for Cadastre and Real Estate Advertising has developed various solutions for integrating the data collected by individuals authorized in the database. These solutions were gradually adopted, the changes being minor between consecutive stages. The National Agency for Cadastre and Real Estate Advertising, taking as a model the cadastre system in Western countries, tried as much as possible to computerize and automate the methods of registration of properties in the Land Book.

From a legal point of view, but also from the point of view of the technical norms applied in the cadastral works, they have had an important evolution in order to ensure the standards in the field. The main stages in the development of the cadastral activity of the country's territory would be:

- The stage of the beginnings of the introduction of the general cadastre, Northern Bucovina starting with 1770, Transylvania and Banat starting with 1794, in Muntenia starting with 1831;
- The stage of unification of the cadastral system (1919 - 1933), comprising mainly the works carried out on the occasion of the appropriations carried out after the First World War;
- The stage of the beginning of the modern general cadastre and of the unification of the Land Books (1933-1955), by law 23/1933 laying the foundations of the way of organizing and accomplishing the cadastre works;
- The stage of land registration and land cadastre systems (1955-1990), a stage that provided for the realization of cadastre works, mainly by photogrammetric methods, in order to prioritize the inventory of state and cooperative agriculture. From this period we have prepared basic topographic maps, at the scales 1: 5000, 1: 2000 and 1: 10000;
- The stage of application of the Land Fund Law no. 18/1991 (1991 - 1996), about 8 million hectares were subject to the establishment and reconstitution of property rights. By creating new surface plots, the old contours of the plots have been modified, which requires the elaboration of new cadastral plans;
- Stage of cadastre and real estate advertising (Law no. 7/1996);
- Reform of the Real Estate Advertising System in Romania, 2004, reuniting the two components: cadastre and real estate advertising in a unique real estate registration system, in accordance with the "Declaration on cadastre in Europe", adopted at the Congress of Granada, in 2002 and from the perspective, from that date, of our country's accession to the European Union. Institutional organization, similar to that of many states in the European Union, which have demonstrated the effectiveness of unifying the two components, Land Book and Cadastre, under a single single coordinating and regulatory authority.
- Sporadic registration of properties. This stage of the sporadic cadastre was a transitional stage, of accommodating the new regulations of Cadastre and Land Book;
- Systematic cadastre 2015-present, ANCPI starts the systematic cadastre works at country level, both at ATU level and by cadastral sectors.

Data on the current state of cadastre, respectively on the properties for which Land Books have been opened are available on the official website of the National Agency for Cadastre and Real Estate Advertising. For sporadic cadastral works there is no concrete evidence, centralized at the country level, but in terms of systematic cadastral works, funded by the National Cadastre and Land Registry Program the evidence of works is periodically centralized by ANCPI.

Chapter 2, "Integration and exploitation of existing data in current cadastral works", highlights various methods of integrating the old topo-geodetic database, respectively the creation of new databases, through innovative methods in order to further integrate them into a GIS system to streamline work.

The national cadastre, as we know it today, is designed as an information system of all lands and real estate, without taking into account their destination. The cadastral works are organized on administrative territories and include a set of cadastral operations, which ensures the

identification, delimitation, measurement and evaluation of buildings, which are identified both on the ground and on the cadastral plans.

The cadastre, along with digitalization, has also undergone a major evolution. It has gone from the old paper records to the electronic, digital records. Although the transition was gradual, many licensees were unable to adapt to new digital technologies and techniques.

Currently, the National Agency for Cadastre and Real Estate Advertising has two records, one analog and one digital. Furthermore, although it has moved to the E-terra 3 computer system that allows the framing of electronic documents, based on electronic signature, the territorial offices as well as ANCPI request the documents in order to register the properties in analog format.

A major advantage of digitizing cadastral works is first of all the high efficiency with which the properties are registered, respectively the much shorter time required to carry out the works. If in the past years works were carried out to register the properties in the Land Book with a certain effort, currently, due to the degree of computerization, respectively of the modern techniques and technologies used, this time has decreased by at least 60%. The integration of measurements using total stations, later GNSS determinations, and currently the use of UAV technology, has made it possible to reduce field operations in cadastral works by over 60%.

Within the office operations, the integration of the data taken from the field in complex databases, respectively the development of new software solutions, currently allow the efficiency of the property records in the Land Book. Using modern technologies, office work is reduced by more than 50% as a time norm compared to their realization using classical techniques.

The registration of properties in the Land Book is a challenge at present, especially due to the confusing legal regulations over time and the lack of a unitary direction in the process of restitution of properties. The works for registering the properties in the Land Book, according to the current regulations are divided into: sporadic cadastre works and systematic cadastre works.

Systematic cadastre works, unlike sporadic cadastre, are works of greater complexity, involving the identification and cadastre of many buildings. One of the most complex tasks in these works is to correlate the old database with the new one. The correlation of these two databases is a challenge for several reasons, such as: the existence of databases in various projection systems, the degree of deterioration of topo-cadastral plates within cadastral offices, atypical, concrete topo-cadastral plates without scale or coordinate system) etc. Also an impediment is the lack of plot plans in certain areas subject to systematic cadastre works, or their inconsistency with the reality on the ground.

In chapter 3, entitled "Modern methods used in property registration works in the Land Book", are presented the main methods for taking over the cadastral details are presented (GNSS methods, photogrammetric methods, terrestrial laser scanning).

A satellite positioning system is a system of satellites that provides autonomous geo-spatial positioning with global coverage. It allows small electronic receivers to determine their position at a given time with an accuracy of several meters using the transmission of radio signals from satellites, based on time. The receiver calculates the exact time as well as the position, which can be used as a reference. Such a global positioning satellite positioning system is called a Global Navigation Satellite System (GNSS).

The appearance of GNSS technology in our country was made in 1992. Since then it has continuously improved, and the specialists who purchased GNSS receivers have become familiar

with this technology with the help of companies providing such equipment, which have provided introductory courses.

Photogrammetry is a technical science that is based on the technology of obtaining information about the Earth's surface and various remote physical objects, without physical contact with them, by recording, measuring and interpreting metric photographic images, called frames. These metric photographic images are used in the preparation of various plans, maps and topographic and thematic studies.

Terrestrial laser scanners are a modern technology that measures fine detail with millimeter precision and captures irregular shapes in order to quickly generate point clouds.

The technology is ideal for measuring and inspecting delimited areas and complex shapes whose description requires large volumes of data and where the use of conventional measurement methods is inefficient.

Due to the high accuracy, laser scanning can be used in various fields of activity such as forest inventory, heritage restoration (historical sites or monuments), modeling of buildings, construction of roads / highways, etc.

In chapter 4, "Geographic Information System", are presented all the aspects regarding the GIS architecture, database models and geospatial data types.

In this era of digitalization, respectively in the economy based on knowledge of competitive societies, information systems for data creation and organization, respectively tools for extracting new information become essential elements in the decision-making process for choosing the best development strategies.

In addition to the classic types of data used in computer systems, geospatial data has seen a considerable development in recent years. This geospatial data involves storing more information about the shape, size and location of various objects around the globe.

The informatic systems that store, process, visualize the classic economic data together with the geospatial data are called geographical information systems, GIS. These informatic systems are becoming a fad, a necessity for a number of companies or institutions working with geographic data. For example, utility companies can monitor local water, gas or electricity networks more efficiently with a GIS. Regional development agencies may use the spatial analyzes provided by geographic information systems to develop documented, consistent development strategies based on the economic and geographical data of the region. Due to the complexity of geographic information systems, and their interdisciplinarity, GIS specialists are reduced in number. In recent years, the international community of open source software developers has made available a number of open source GIS components almost as robust and powerful as their proprietary ones. The open source web GIS community adopts OGC standards, including WMS, WFS, to ensure interoperability.

Chapter 5, „Case study 1 - Automation of systematic cadastre works on extravilan cadastral sectors” includes an area outside the build-up area from Tăuții Măgherauș territorial administrative unit, Bozânta Mare locality, subject to systematic registration works, according to the National Cadastre and Land Book Program developed by the National Agency for Cadastre and Real Estate Advertising.

Also within this chapter are presented in detail all the necessary stages for the realization of the cadastral plan, namely: the realization of the orthophotoplan, support for the cadastral works;

vectorization of plots and their integration in databases; database creation and measurement integration; editing data collection and updating using mobile devices; realization of the cadastral plan and generation of annexes; creation of an online platform called XMLPARSER.py for publishing data in order to formulate and resolve contestations.

In order to generate the list of coordinates and display the buildings on the map for the online platform, we created a program written in the Python3 programming language, which processes all CGXML files in the "files" directory and extracts the following elements: point coordinates, owner name / of the holder, first name of the owner / holder, parcel number - CADGENNO, surface.

In chapter 6, entitled „Case study 2 - Automations in sporadic cadastre works in the urban area” presents the utility of photogrammetric UAV technology for obtaining and using orthophotomaps in the sporadic cadastre works and also using the terrestrial laser scanning technology as a method for data acquisition.

Unlike systematic cadastral works, which are carried out either at the level of ATU or at the level of cadastral sectors, which often have a considerable area, sporadic cadastral works are carried out on relatively small areas, and in most cases in urban, where buildings can be easily capitalized.

The sporadic cadastre is made at the request of the beneficiaries, mainly when they want to develop those properties, or to make various investments, which require the presentation of an updated land book.

In chapter 7, entitled "Conclusions and recommendations. Personal contributions", are presented, in a first phase, the general conclusions regarding the automatization of cadastral works and the conclusions regarding the case studies, as well as the proposals elaborated following the research made regarding the case studies.

The works of property registration in the Land Book, especially in the context of the numerous contradictory legislative regulations constitute a real challenge for the specialists in the field.

The inconsistencies very often encountered between the property deeds and the real situations encountered on the spot make the correct identification of the owners a difficult task. The identification of the properties, but also the communication of the results obtained to the owners / possessors must be done in the most transparent way possible. Using online communication platforms, owners / possessors can very easily view cadastral data and formulate rectification requests in an automated way.

Data retrieval using modern technologies such as UAV Photogrammetric technology or terrestrial laser scanning allow the efficiency of cadastral works. The UAV photogrammetric method gives the possibility to measure large areas in a short time and with minimal financial effort.

In the first case study, the methods of automation and computerization of property records in the land book within the systematic cadre works were approached. Following the analysis of the techniques and technologies presented, the following can be concluded:

- Realization of an orthophotoplan, by UAV photogrammetric methods represents a major advantage in the identification and perimeter of the properties and implicitly in the automation of the measurement process;

- Automatic vectorization of plots is a topic of great interest in order to computerize and automate the process of registration of properties in the land book, but this will have to be, until the development of automatic methods of vectorization to be supplemented by manual vectorization;
- The implementation of complex databases that offer the possibility to publish them on online platforms confers a great advantage both in the process of collecting cadastral data and in the process of displaying the results;
- Using mobile data collection devices, databases can be updated in real time, thus automating and computerizing the process of registering properties in the land register.

In the second case study, the methods of automation and computerization of property records in the land book within the sporadic cadastre works were approached. Following the analysis of the presented techniques and technologies, the following aspects can be concluded:

- The exploitation of the Orthophotoplan and of the point cloud obtained by UAV photogrammetric methods confers a great advantage in the automation and computerization of the entries in the land book, thus the modern methods approached significantly reduce the time required to collect measurements.
- Terrestrial laser scanning is a modern method of data retrieval that provides high accuracy of object modeling, thus eliminating the production of errors due to omission of details in the case of classical measurements;
- By scanning the terrestrial laser, in addition to obtaining the data necessary for the registration in the land register of the buildings, a complex model is obtained that can be integrated in a BIM, but a step is made towards the implementation of a 3D cadastre.

In order to streamline, automate and computerize the process of registering properties in the land register, especially in the context of current technology development, it is recommended to take the following measures:

- Efficiency and automation of data collection in the field, by completing the classical measurements by UAV photogrammetric surveys;
- Creation of complete databases, containing both old topo-cadastral data, plans, plot plans, etc., as well as new data taken over by modern measurements;
- Integration of the database in online platforms, in order to be accessed and updated from mobile devices;
- Publishing the results in the case of systematic cadastre works on a public online platform, in order to facilitate access to data and formulate possible appeals by owners / holders;
- If, following the systematic cadastre works, at the level of the land, the parcel situation changes compared to the current use, it is recommended to draw the new property limits.

Taking into account those presented in the content of this doctoral thesis, the following contributions are distinguished:

- Analysis of the evolution in time of the methods of registering the properties in the Land Book;
- The current stage regarding the registration of the properties in the Land Book and the degree of computerization of these records;

- Presentation of techniques and technologies for integrating old cadastral databases into modern databases, but also presentation of modern techniques for performing topo-cadastral measurements;
 - Creating a complex database in order to automate and computerize systematic cadastre works;
 - Realization and processing of aerial photogrammetric surveys within the works of systematic cadastre - cadastral sector 93 ATU Tăuții Măgherauș, Maramureș county;
 - Obtaining the specific deliverables for the systematic cadastre works for the cadastral sector 93 ATU Tăuții Măgherauș, Maramureș county
 - Creating an online platform for publishing and formulating possible appeals on systematic cadastre works for the cadastral sector 93 ATU Tăuții Măgherauș, Maramureș County
 - Realization of two series of UAV photogrammetric surveys of an area of about 28ha totaling 260 buildings from the Roma community of Finteușu Mic locality, ATU Satulung, Maramureș county;
 - Scanning the “Holy Trinity” Cathedral of Baia Mare and obtaining the cloud of georeferenced points, in order to 3D model it;
- The doctoral thesis ends with the References and Annexes.