APLICATION OF MODERN MEASUREMENT TECHNOLOGIES IN THE PROCESS OF SISTEMATIC REGISTRATION OF REAL ESTATE

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Abstract. With the passage of time and advancement of modern technology, new work methods and ideas are introduced and applied regularly in the field of topography and, by association, cadastre. The entirety of cadastral works rely on topographical methods for the obtaining of information necessary for the documentation of real estate such as parcels and constructions. It is within any country's interest to not only have a national-level registry in which real estate is systematically documented but to also regularly update it. This paper aims to introduce new technological concepts of data retrieval and processing in the process of execution of cadastre and land registry works, integrating Smart technology, namely GNSS and UAV technology, into the efforts of the National Program of Cadastre and Land Book for the systematic registration of real estate. This area in which these efforts have been made is located in Ialomiţa county, Muntenia, Romania, namely the Territorial Administrative Unit of Albeşti (Albeşti, Bataluri and Marisilieni villages). Since the beginning of this project, the National Agency for Cadastre and Real Estate Advertising has taken care of all necessary steps (legislative and operational measures) to accelerate the systematic registration works and to contribute to the conclusion of contracts for cadastral sectors.

Keywords: GNSS, UAV, topography, technology, real estate, cadastre

INTRODUCTION

Starting from the general understanding of cadastre, centered on the basic entities of an integrated cadastre and land registry system, namely the estate and the estate owner, this paper aims to introduce new technological concepts of data aquirement and data processing when it comes to the execution process of cadastre works and registration.

The estate represents the key element in everything related to the registry enlisting process. The general area where the cadastre work is executed is located in Ialomiţa county, Muntenia, Romania, and consists of in towns of Albeşti, Bataluri and Marsilieni.

The necessity of the implementation of the National Cadastre and Land Registration Plan (PNCCF), targeting to register the estates of the entire Albeşti ATU in the integrated cadastre and land registry, has been as much a local-level priority as a regional one, thus maintaining the upward trend of systematic registration of real estate throughout the country.

All the information regarding the owners, estates, possessors and legal holders is obtained after carrying these systematic registration efforts and made available to the public, under the law. All persons involved in this PNCCF 2015-2023 process, be it physical or legal persons, authorities or other entites, are obliged to comply with the provisions of the Law nr. 677/2001, for the protection of individuals with regard to the processing of personal data and the free circulation of such data.

Passing through the stages of the PNCCF's procedures, begining with the public information campaign, depending on the particularities of the TAU and the needs, until the request for rectification of the information in the published technical documents, the results of the documentation of the buildings within the project can be found both in the written records of the agency (ANCPI) and in the online environment through the eTerra program, ANCPI Geoportal.

MATERIAL AND METHODS

For this work, both GNSS Rover (GPS South G7) and UAV technology, namely and RTK drone (eBee X).

GNSS (Global Navigation Satellite System) technology is a complex electrotechnic system which consists of an ansamble of terrestrial and cosmic equipment that allow for the determination of positions (geografical coordinates and heights) with high precision and the movement parameters (speed and direction of movement) of terrestrial, aerial and aquatic objects. The methods for the determination of position are based on observations gathered from satellite signals through microwaves. The transmission stream of the satellite signal is usually continuous or can pulse at regular intervals. The reception of these signals is carried out similarly.

Satellites have an active role, broadcasting signals that are recieved by special instruments that decode the signals (recievers). Following the decodification of these signals, the information necessary for the determination of the receptor's position is extracted. GNSS satellites transmit to the user information regarding time, navigation and notifications regarding the state of the system. The control segment is responsible for keeping the satellite constelation, the attached time system and the determination of satellites' orbits active.

Figure 1. GPS system, South G7.

For the given study, using GNSS technology, we have utilized the **GPS South G7** (Figure 1.).

Figure 2. RTK drone model with fixed wing, eBee X.

Sensefly's **eBee Plus** drone (Figure 2) is a drone aimed towards the making and obtaining of maps and large terrain surface maps by capturing aerial photos. This device stands out with details such as a larger wingspan, the incorporation of a fotogrammetric camera and certain high-precision surveillance functions. Sensefly eBee Plus was equipped with a high-precision system which offers *Real Time Kinematic* navigation (real time navigation through GPS) and post-porcessed kinematics (similar function to the previous one, although in this one periodic control points can be established through GPS).

Regarding the data processing, three softwares were used. For the GNSS technology, **AutoCAD 2013** was used for the data, **Pix4D** was used for the orthophotoplan part and the program **eMotion** was used for the eBee X drone.

AutoCAD is a CAD program utilised in the projection of construction plans in two dimensions (2D) and, lesser, in three dimensions (3D), developed and commercialized by the american company Autodesk.

Pix4D is a software used mainly used in the field of topography for mapping with the help of the UAV platforms, representing the utmost adequate tool for data processing. The images obtained with the help of the UAV platforms are transformed into digital spatial models with the help of the local hardware technology, thus intervening in the process of improving the quiality of the projects, generating reports on the results, calibration details. The operator can set the coordinate systems even during creation of a new project, one system for the images' center, and another for the Ground Control Points (GCPs).

The steps prior to the data collecting and processing are as follows:

- The target zone is determined and the flight plan is generated, which loads in autopilot;

- During flight, the drone takes pictures which overlap by 70% each and registers the geographic position of each picture;

- After landing, the pictures and data are downloaded from autopilot, after which they will be colored in with the help of the pre-processing software;

- The images are processed with the help of last-generation programs and follows three important steps: aligning the images using the common points between them (resulting in a cloud of points); the geometric reconstruction through which the tridimensional position of each point is calculated (resulting in a 3D model); exporting the results in formats that are compatible with the analysis/projection programs.

RESULTS AND DISCUSSIONS

The area in which the general cadastre efforts have been made is located in Ialomița county, Muntenia, Romania, consisting of the villages of Albești (residence), Bataluri and Marsilieni.
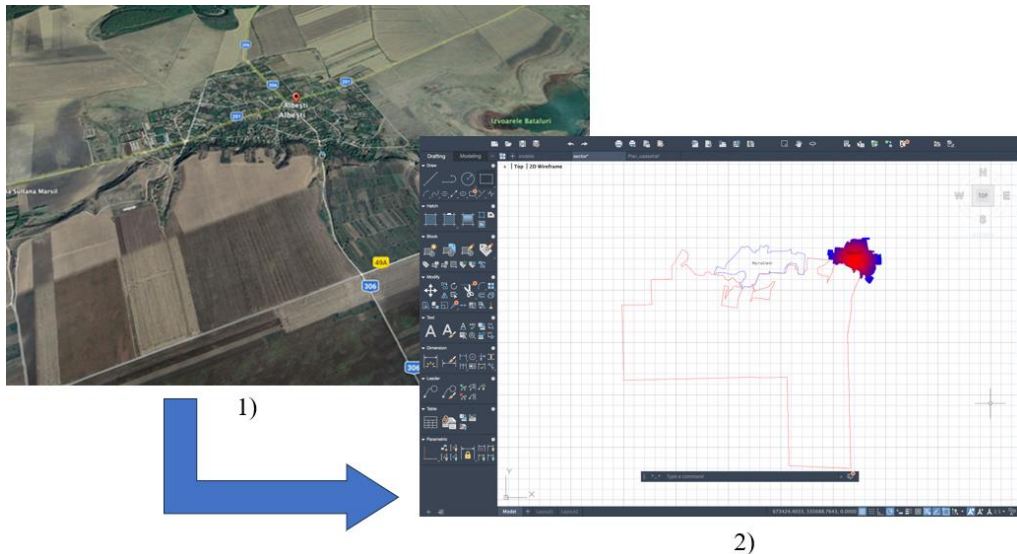
Figure 3. Positioning of Albesti commune in Ialomița county (1) and the Albesti ATU limit in the cadastral sector 10 at 1:10000 scale (2).

The case referred to in this paper is cadastral sector of the Albești TAU.

The cadastral sector consists of the following estates:

1.   Total number of estates **N1** *(according to the Quantitative and Qualitative Reception Report no. 554 / 16.01.2023 of OCPI Ialomița) = 1693*

2.   Number of estates with identified owners/holders subject to work **N2** *(according to the Quantitative and Qualitative Acceptance Report no. 554/16.01.2023 of OCPI Ialomița) = 1592*

3.   Number of estates with unidentified owners, subject to the provisional registration of Albești TAU **N3** *according to the Quantitative and Qualitative Reception Report no. 554 / 16.01.2023 of OCPI Ialomița) = 101*

4.   Number of estates included in parcel plans made on the basis of financing contracts from public funds and/or buildings that have been registered in the integrated cadastre and land registry system as a result of systematic registration, financed from public funds **N4** (according to the Quantitative Acceptance Report and no. 554/16.01.2023 of OCPI Ialomița) = *0*

Table 1

The situation of the buildings in Cadastral Sector no. 10, A.T. U. Albești

	Nr. of out-of-town estates 1	Nr. of out-of-town estates 2	Total nr. of estates 3=1+2	Surface of total nr. of estates (ha) 4
A – TOTAL RECEPTIONED ESTATES (A=B+C+D), of which:	1691	2	1693	1506,2905
B - Real estate with identified owners/owners subject to full payment, payment of 100% of the unit price per real estate	1590	2	1592	2358,1190
C - Real estate with unidentified owners, subject to provisional registration of the TAU payment of 100% of the unit price per real estate	101	0	101	148,1715
D - Buildings not subject to settlement -Buildings included in parcel plans made on the basis of public financing contracts -Buildings that have been registered in the integrated cadastre and CF system as a result of systematic registration, financed from public funds -Individual units in condominium constructions	0	0	0	0

The estates presented in the table above (Tabel 1) make the object of this paper and, together, make up the unique cadastre and real estate advertising register of this A.T.U., which is kept by the territorial office.

Data collection in this real estate registration process can be done in several directions, depending on the need, actual execution time imposed by contract or other implicit conditions. Therefore, this paper, by the transposed data, aims to implement modern technologies of taking over and processing in order to achieve the main objective, in a very short time and with high accuracy.

The specialized topo-geodetic works within the project were carried out in the National Stereographic Projection System 1970 (Stereo70), in accordance with all norms in force. The situation of real estate in Cadastral Sector number 10, extravilan, according to the law, the buildings must be consistent with the situation of real estate reflected in the real technical and legal documents, unless proven otherwise.

In order to integrate the data, ANCPI needed the help of providing the application mentioned above, Generate CG. After the process of taking over and processing the data measured in the field (graphic data), the database was created with a record for each building. Once created, a unique ID was assigned to each building, identical to the one in the text database. The results were used in all preparatory work for the elaboration of written and drawn parts of the project, as well as for the final technical documentation.
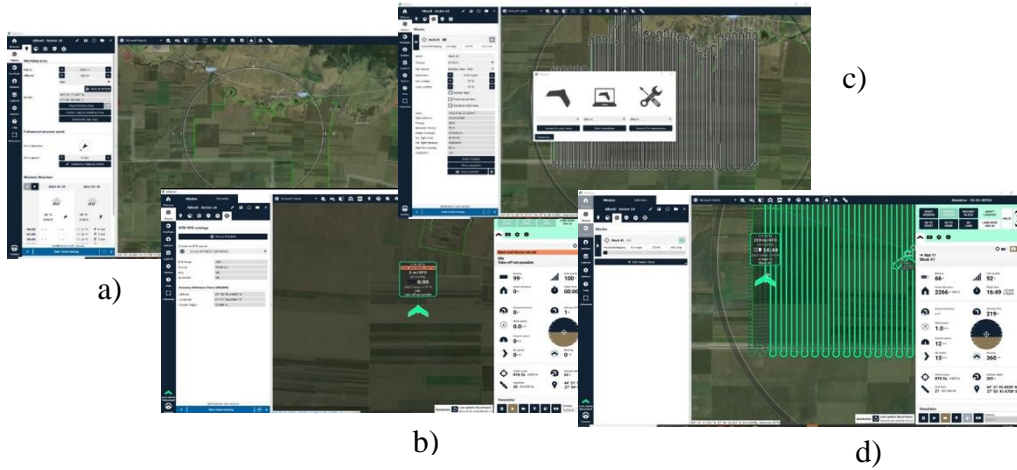
Figure 4. Working in the program eMotion.

Once the data has been collected with the help of the two technologies, GNSS and UAV respectively, we can say that the field work stage is done, and begin processing the data in the office through the specific methods for each technology.

As stated earlier, the processing of the UAV data was done using a fotogrammetric program, which allowed for the processing of data in significantly larger portions. Said program, Pix4D Mapper, represents one of the important markers of the fotogrammetric technology spectrum, utilizing a considerable database (images) for the generation of point clouds, orthomozaics, textured digital models, etc. The work flow and the processing data aquisition method are presented in the Material and Methods section.
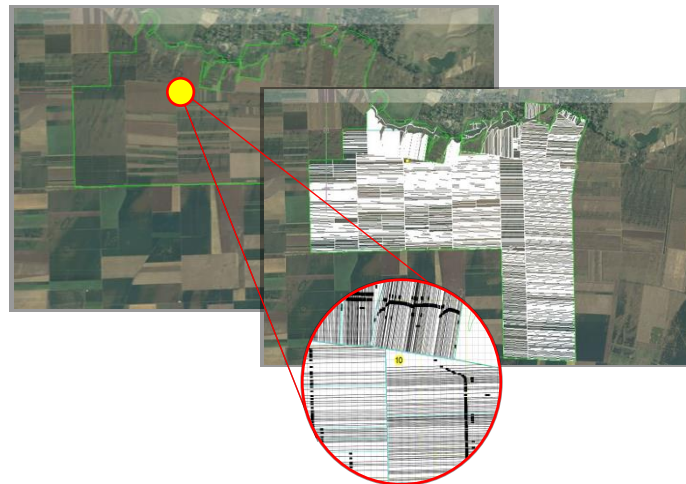

Figure 5. Orthomosaic and overlapped estates in Sector 10, Albesti ATU, Ialomita county, in AutoCAD.

Following the process of each step, the processing report will automatically open with all the information regarding the quality of the obtained results.

Having set up the entire photogrammetric database with the expected final result, the orthomosaic of the area, the process of working on cadastral plans and their overlapping on photogrammetric elements begins.

The general cadastral plan was made and printed at scale 1:2000 in a clear format, so that all figured elements can be distinguished: building boundaries, ID, etc
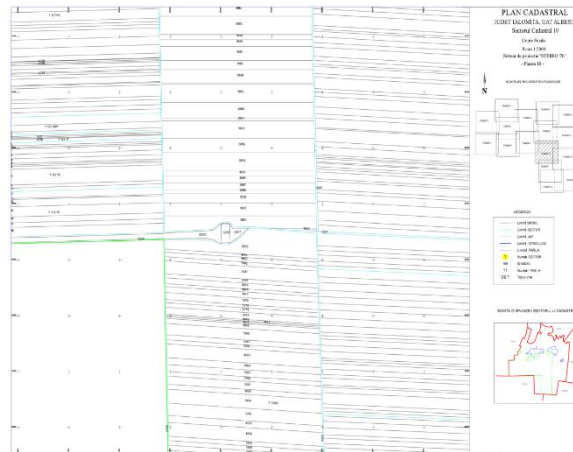

Figure 6. Cadastral plan with cadastral Sector 10, Albesti, Ialomita (*format model tiff*).

In these plans as well were added important elements such as: title, sketch of connection of plans, legend, name of the contractor, the carioage.

As a brief conclusion of this chapter, the new measured limits are integrated into the overall general plan, as a result of cadastre works and identification of estate boundaries, as well as cadastral sector boundaries.

CONCLUSIONS

The main purpose of the study is to integrate Smart technology into the National Program of Cadastre and Land Book, taking into account the statistical basis of systematic registration works. According to the law nr. 7/1996, the General Cadastre is identified as a unitary and mandatory system, having technical, economic and legal functions. The importance of the general cadastre, at national level in Romania, is noted by providing real data on real estate (position, area, use, owner), necessary for all branches of the national economy.

Following the engineering and cadastral measurements made outside the built-up area of Albești, Ialomița County, it was noted that the involvement of modern technology (UAV equipment) led to high accuracy in the field of engineering works, but also to obtaining three-dimensional visual information of an area of interest.

In order to carry out this work, a qualified staff was needed, a very good knowledge of the works by the manager executing the project, subsequently he also had the responsibility to draw up the tasks of the team. The collaboration relationship between the contractor's team and the National Agency for Cadastre and Land Registration should be maintained properly throughout the project, in order to facilitate the work of data retrieval by the provider. This is welcome, in order to avoid difficulties in identifying real estate and ease the work related to property deeds.

In such a work as this, systematic problems regarding property deeds can arise, but also various material mistakes. This can happen due to lack of interest from local authorities or level of training.

These cadastre works cannot fully solve the problems related to the field cadastral, however, can reduce the cadastral situation at the level of a Territorial Administrative Unit, so that some problems remain to be solved by civil courts.

In order to be able to work more easily with the field data needed to carry out the registration works, it is necessary to organize an archive, such as DDAPT, digital for consultation.

One thing that was helpful in carrying out this work was the free DDAPT platform, so that everyone could benefit from it, and the buildings with the related property limits could be easily identified.

Since the beginning of this project, the National Agency for Cadastre and Real Estate Advertising has taken care of all necessary steps (legislative and operational measures) to accelerate the systematic registration works and to contribute to the conclusion of contracts for cadastral sectors.

ANCPI supported the financing of systematic registration works for the Territorial Administrative Units of the cadastral sector, works that were carried out at the level of the A.T.U.

The National Agency for Cadastre and Land Registration helped support infrastructure, the economy in general and agriculture.

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