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NVESTIGATION OF THE EFFICIENCY OF INTEGRATING THE CADASTRAL MAP WITH A MAP OF THE RESTORED PROPERTY ON THE TERRITORY OF THE REPUBLIC OF BULGARIA

ABSTRACT

of a dissertation for the award of the educational
and a scientific degree "Doctor" in a professional field
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The defense of the dissertation will take place on ..... from ..... in the hall ... . on the case .....

The materials on the defense are available at the University of Shumen "Episkop Konstantin Preslavski", 115 Universitetska Str., Building 1, office 107, as well as on the website of the university - http://shu.bg/.

I. GENERAL CHARACTERISTICS OF THE DISSERTATION

1. Relevance of the topic

The topic of this dissertation is related to the problems caused by the integration of the cadastral map with the map of the restored property.

The integrated cadastral map and cadastral registers are a complex set of elements that: form a whole (have a structure); are interconnected; interact to achieve a specific goal.

In 2015, the Concept for accelerated creation of a cadastral map and cadastral registers and acceleration of the process of creating a property register was adopted.

The purpose of the concept is to accelerate the process of creating cadastral map and cadastral registers (CMCR) for the whole country, by developing CMCR for non-urbanized territory, using data from map of the restored property (MRP) MRP.

In the practice of AGKK - in the process of establishing the CMCR and keeping the already approved CMCR up-to-date, discrepancies are found in the non-urbanized territory, which have been transferred to CMCR by MRP. When establishing the CMCR, discrepancies are found only within the boundaries of the contact zone between the urbanized and non-urbanized territory. Their removal is regulated in [14] and [22].

When maintaining the CMCR, the discrepancies in the non-urbanized territory are found incidentally - on the occasion of specific applications from individual stakeholders. In most cases, the identified discrepancies are inaccurate or missing topographic sites of natural or artificial origin - rivers, ravines, roads, technical infrastructure.

By accelerating the process of covering the territory of the country with CMCR, AGKK developed CMCR for this part of the non-urbanized territory of the country, for which after analysis of the numerical model of MRP - by land, no gross errors were found. For these lands CMCR was established in a shorter time, reduced volume of activities and financial resources.

2. Object, subject, purpose and tasks of the research

The motive for choosing, formulating and developing the topic is the lack of a number of unresolved issues in creating a cadastral map and cadastral registers, eliminating inconsistencies in the integrated cadastral map and cadastral registers, which must be studied, analyzed and presented with appropriate technological solutions.

The goal of the dissertation is:

To study the effectiveness of integrating the cadastral map with the map of the restored property and to create a methodology for its increase.

To achieve this goal, it is necessary to solve the following tasks:

1. To analyze the sources of errors in the integrated cadastral map.

2. To create a methodology for identifying discrepancies in the integrated cadastral map.

3. To carry out real experimental research, analysis and evaluation of the results for establishing discrepancies in the integrated cadastral map.

The subject of the study is to reveal the state of the integrated cadastral map and cadastral registers at the moment and its impact on the users of cadastral data.

The object of the study is the integrated cadastral map on the territory of the Republic of Bulgaria.

The main working hypothesis of the study is: The existing problems in integrating the cadastral map with the map of the restored property, and an attempt is made to propose solutions to these problems by developing appropriate methodologies for their application in geodetic practice.

The scope of the research is: national, regional and local; time - from 2019 to 2022 with a special focus on experimental research to confirm theoretical conclusions and judgments.

The research methodology is based on publications on the researched problem; comparison; statistical analysis and experimental research. On the basis of the research, reports presented at scientific conferences in the country were prepared and implemented.

The scientific novelty of the research is expressed in:

• The sources of errors in the integrated cadastral map and cadastral registers are analyzed.

• A methodology for establishing a clear factual error in the integrated cadastral map has been developed.

• A methodology for identifying incompleteness and errors in the integrated cadastral map has been developed.

The expected result of the research is to prove that the integrated cadastral map and cadastral registers contain many inconsistencies and this affects the users of cadastral data.

II. VOLUME AND STRUCTURE OF THE DISSERTATION

The dissertation has a volume of 209 pages and consists of an introduction, four chapters, a conclusion, a list of abbreviations used, a list of references and appendices.

The introduction argues the relevance of the problem, the object, goals and objectives of the study. Each of the chapters is structured in several sections and at the end of each chapter conclusions are made on the issues discussed.

The structure of the dissertation includes:

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III. BRIEF DESCRIPTION OF THE DISSERTATION

The introduction substantiates the relevance of the research, defines the purpose, research objectives and object of the dissertation, the approach adopted and the methods used.

Chapter One. ANALYSIS OF THE REGULATORY REGULATION

2.1. Regulatory base

2.1.1. The legislation in the period 1879-1944

The need for a land cadastre appeared immediately after the Liberation of Bulgaria from Ottoman rule. In the Organic Statute of Eastern Rumelia (April 14, 1879) in Chapter 14 - "Structure of land ownership" in Art. 484 mentions the forthcoming "four bills on land ownership", and in Art. 485 states: "The first of these bills should be aimed at making an inventory (cadastre) of land owned in the area."

2.1.2. The legislation during the period 1944-1979.

After 1944, the cadastre was neglected and for a long time there was no special law for it.

In the period from 1950 until the entry into force on January 1, 1980 of the Law on the Unified Cadastre of the People's Republic of Bulgaria, the cadastral

matter is regulated by the Law on Planned Construction of Settlements and the Law on Territorial and Settlement Planning.

2.1.3. The legislation in the period 1979 - 1990

The Ministry of Construction and Architecture organizes through the General Directorate of Geodesy and Cartography the development of Basic Provisions for the Establishment of the Unified Cadastre of the People's Republic of Bulgaria. The main provisions were adopted by the Operational Bureau of the State Council with Protocol № 28 of 3 November 1975 and on the basis of this document the bill was prepared.

2.1.4. The legislation in the period 1990 - 2000

After 1990, a number of laws came into force in Bulgaria, the main of which are the Law on Restoration of Ownership of State-Owned Real Estate, the Law on Restoration of Ownership of Certain Expropriated Properties under the Law on Spatial Planning, the Law on Planned Settlement for the improvement of settlements, the Law on State Property and the Law on Property, the Law on the Ownership and Use of Agricultural Lands and the Law on the Restoration of the Ownership of Forests and Lands from the Forest Fund**.**

2.1.5. Legislation in the period 2000 - today

On 01.01.2001 the Law on the Cadastre and the Property Register entered into force, which with §8 of the transitional provisions repealed the Law on the Unified Cadastre of the People's Republic of Bulgaria. For its part, the Spatial Planning Act, in force as of March 31, 2001, repealed the Law on Spatial Planning and the regulations for its implementation, thus ending all existing provisions regulating activities related to the cadastre.

2.2. Manifest factual error / MFE /

2.2.1. Establishing a manifest factual error

The latest amendment to the Law on Cadastre and Property Register (dated 22.07.2016) introduced a new definition of "obvious factual error" and a new administrative procedure for its removal in the cadastral map. Two hypotheses are included in the concept - two different cases of inconsistency:

1. The "contact zone" obtained by combining the sources for the creation of the cadastral map, when there is a difference in the common border between the sources for urbanized and non-urbanized territory and as a consequence part of the restored agricultural land or forests and land in forest territory is established that they have been wrongly restored in an urbanized area, or that there is an area that does not fall into any of the sources;

2. "Manifest factual error", representing inCRrect restoration of agricultural land or forests and lands in forest territory, due to inCRrectly determined in the restoration location of existing on the site (terrain) permanent topographic sites of natural or artificial origin (roads, water bodies) etc.), which should not have been part of the restored properties under the Law on Land Acquisition and Land Use Planning Act.

2.2.2. Elimination of obvious factual error

Regardless of the mixing in the definition of the two phenomena in CPRA and in Ordinance № RD-02-20-5 of 15.12.2016 on the content, creation and maintenance of the cadastral map and cadastral registers, different procedures for eliminating discrepancies are regulated:

- In the process of creating a cadastral map and cadastral registers, even before the acceptance of the developed cadastral map for elimination of discrepancies within the boundaries of the land properties, obtained by combining the data under Art. 41, para. 1 [14], the legal person shall draw up a map of the contact zone and a list of the affected properties in the territory of the contact zone.
- After accepting the cadastral map and after reflecting the reasonable objections under Art. 48, para. 2 [14], the competent person under Art. 35, para. 2 [14], respectively under Art. 35b, para. 2 [14], CRrects the list of affected properties and prepares projects for elimination of the established incompleteness or error, or obvious factual error.
- After approval of the cadastral map, for elimination of obvious factual error and incompleteness and errors, when the map is within the warranty period, art. 42 para. 4 to para 15 [44].

2.2.3. Materials provided by AGCC

The Agency for Geodesy, Cartography and Cadastre, through the Geocart Fund and the respective Service for Geodesy, Cartography and Cadastre

(SGKK) at the location of the site (s) provides the contractor in stages by land the following materials and data:

Coordinate register and scheme of the geodetic basis for the territories in digital form;

2. Approved CMCR by the order of § 33 of the TFP to the AAS of [14] (promulgated SG, issue 57 of 2016) in digital form;

3. The analyzes obtained as a result of the implementation of the contracts for "Valuation of the restored property card in order to create a cadastral map and cadastral registers, the basis of a unified system for maintaining cadastral data and providing services from them" from 2015.

4. Provided graphic materials in digital form - graphically processed format and data from departments, municipalities and other legal entities for real estate - their property, as well as for managed, managed and used real estate - object of the cadastral map, incl. and data on the property-forming easements or restriction zones that they give rise to.

5. Data from the PES for established obvious factual errors by the order of art. 26, para. 10 of the Regulations for the implementation of the law on the ownership and use of agricultural land.

6. Map of the restored property, current as of the date of approval of the CMCR.

2.2.4. Geodetic measurements to eliminate obvious factual error

Geodetic measurements cover marked boundaries of existing and new cadastral sites in the scope of the change, design boundaries after tracing - in urban areas, as well as boundaries of permanent topographic elements of natural or artificial origin in non-urban areas, when they represent property boundaries.

The geodetic measurements of the land properties affected by the established obvious factual error shall use the existing geodetic basis or, if necessary, create a new geodetic basis, after prior coordination with the Service of Geodesy, Cartography and Cadastre and in compliance with the requirements of Ordinance № РД-02- 20-5 of 15.12.2016, allowing the use of GNSS in RTK mode.

2.2.5. Project for amendment of the cadastral map and cadastral registers

The project for amendment of the cadastral map and the cadastral register of the real estates is made for a land property, affected by the established obvious factual error and for missing objects of the cadastre. When several neighboring land properties fall within the scope of the MFE, an amendment project is prepared.

2.2.6. Materials submitted to AGCC

As a result of the performed activities, the contractor presents the following materials and data:

1. Report on the performed land activities for the respective municipality.
2. Materials and data for the geodetic basis.
3. Materials and data for the map with the combined data for the territory, in the scope of which fall the properties, affected by the established obvious factual error.
4. Materials and data for the developed projects for amendment of the cadastral map and the cadastral registers, including schemes of the separate sites in buildings by floors - in digital and graphic form.
5. List of properties affected by MFE, containing the results of the analysis.

2.3. Incompleteness and errors in the CM and CR

2.3.1. The essence of the concepts of incompleteness and errors

The generally accepted logical sense in which the term "incompleteness" is used is associated with a complete lack or lack of sufficient information about certain circumstances or facts. The term "errors" means inCRrect perception or reflection of facts and circumstances of objective reality. The CPRA in its original version, when it entered into force on 01.01.2001, uses these two terms related in the form of the legal and technical term "incompleteness and errors in the cadastral map and cadastral registers", which has no legal definition in the law, but is included in a number of normative texts.

2.3.2. Incompleteness and errors acCRding to art. 53 and Art. 54 of the CPRA

The most essential for the law enforcement norms of CPRA, where the considered concept is regulated, are the texts of art. 53 and 54.

2.3.3. Identification of incompleteness and errors

Detection of incompleteness and errors can be during the control of CMCR, when it is created and accepted and after its approval. In modern technologies this is not difficult, on the contrary it is possible with unmanned aircraft to identify gaps in the content of KKK the reflection of buildings and facilities from the technical infrastructure.

2.3.4. Documents submitted to the SGCC by the owner

The owner (the interested person) submits the following documents to the SGCC:

• Request.

• Copy of ownership document - notary deed, contract of sale, contract of division, court order, for lands restored under the Land Use Planning Act and the Land Use Planning Act, decision of the Municipal Service "Agriculture and Forestry" (former land commission), accompanied by a sketch of the property.

• Sketch project.

The project sketch is made by a qualified person in the cadastre and contains:

• The sketch of the property;

• The line showing the CRrected location on the boundary of the land property or the outlines of a building, or the supplemented boundary or buildings and their identifier.

2.3.5. Causes leading to incompleteness and errors in the cadastral map and cadastral registers

The reasons for the mistakes can be:

• Failure to fulfill the obligations of the owners under Art. 36 and 38 CPRA, as well as the protocol with which this non-fulfillment under Art. 33, para. 5 of [44].

• Due to the fault of the competent person who prepared the cadastral map and the cadastral registers.

2.3.6. Changes in the legislation to eliminate incompleteness and errors

With the introduced amendment to the CPRA in 2014, the administrative body in the person of AGCC can establish the incompleteness or error and change the cadastral map after submitting a draft amendment containing geodetic measurements and documents proving the incompleteness or error.

Conclusions and summaries to chapter one

Based on the literature review and its analysis of the legislation, the establishment of obvious factual error and the establishment of incompleteness and errors, the following conclusions can be drawn:

1. The laws and by-laws, applicable in the field of cadastre and the establishment and elimination of discrepancies in the integrated cadastral map, are considered.

2. In Bulgaria there is a legal framework providing an appropriate basis for maintaining an effective system of land administration. However, there are a number of weaknesses in the implementation of this legal framework that need to be addressed.

3. The presence of an obvious factual error is a relatively common phenomenon in the cadastral map. They apply mainly to linear objects and it is quite possible to eliminate them, both with individual projects for specific errors and with projects affecting a large part and even the whole land.

4. The presence of incompleteness and errors in the cadastral map is a common problem in recent years, which is solved in two ways:

- by conducting an administrative procedure by AGCC;
- in court, if there is a dispute over substantive law.

Chapter two. SOURCES OF ERRORS IN THE INTEGRATED CADASTRAL MAP AND CADASTRAL REGISTERS

2.1. Geodetic basis - different coordinate systems

2.1.1. Geodetic basis

The basic geodetic base of Bulgaria consists of the State GNSS network, the State Leveling I - III class, the geodetic networks with local purpose V - VII class, as well as the gravimetric network of the country.

2.1.2. Coordinate systems

The coordinate systems in which the BER was created and the cadastral plans are in the local coordinate system, the 1930 coordinate system, the 1950 coordinate system and the 1970 coordinate system. [31]

2.1.3. Transformation of classical coordinate systems in BGS 2005 [28]

The procedure for transforming coordinates from the classical systems used in the country in BGS2005 consists of three stages [28]:

1. transformation of the output coordinates into six-degree Gaussian coordinates in the "1950" system;

2. Transformation of the six-degree Gaussian coordinates into the 1950 system In geographical coordinates in the system "1942/83";

3. transformation of the geographical coordinates in the system "1942/83" in BGS2005.

The first stage of the transformation takes place in different variants depending on the coordinate system of the output data.

2.1.4. Estimation of the accuracy of the areas from the cadastral map during the transformation from the classical coordinate systems to BGS2005

In geodesy, the formula is used to calculate the area:

$$P = \frac{1}{2}\sum_{1}^{n} Y_i(X_{i+1} - X_{i-1}), m^2 \qquad P = \frac{1}{2}\sum_{i=1}^{n} X_i.(Y_{i+1} - Y_{i-1}) \tag{2.58}$$

Where Xi and Yi are the coordinates of the angles of the polygon.

From the law of transmission of errors we receive:

$$m_P = \pm\frac{1}{2}\sqrt{m_X^2\sum_{1}^{n}(Y_{i+1} - Y_{i-1})^2 + m_Y^2\sum_{1}^{n}(X_{i+1} - X_{i-1})^2} \tag{2.59}$$

where mX and mY are the mean square errors of the coordinates.

The accuracy in determining the areas is regulated in [44], where the error is estimated by the difference between two independent calculations of the area:

(2.60) $$\Delta P_{доп.} = \pm 2\,\partial S\sqrt{P}, m^2$$

Where ∂S is the error in the distance between two points.

To estimate the accuracy of using the coordinates of the points, the formula should be used:

(2.61) $$\Delta P_{доп.} = \pm 2\Delta S\sqrt{P}, m^2$$

Where ΔS is the absolute position error of a detailed point.

When calculating the errors in the areas determined by the coordinates of the defining boundary points of the land properties, it must be taken into account that ΔS depends on the accuracy of the coordinates.

2.2. Source materials (multiplication of errors from current plans)

The cadastral plans approved by the repealed LACRB or the repealed LTSU, and § 40 of the transitional and final provisions (TFP) of the Law on Amendments to the CPRA are usually on a traditional medium, therefore it is necessary to convert them into numerical form.

Creating a digital plan or map from existing graphics can be done in two main ways:

- by digitization - the obtained graphic information is in vector form;
- by scanning - the obtained graphic information is in raster form and by vectorization it can be converted into vector form.

2.2.1. Digitization

Digitization is a process of transforming graphic information from plans, maps, diagrams, etc. in analytical information - coordinates of individual points and lines, represented by coordinates of their bends. The aim is to convert the graphic database into a vector database.

2.2.2. Scanning

Scanning is the automated conversion of graphic, text and photographic images into digital form through devices called scanners.

2.2.3. Errors in digitizing existing plans and maps

Cadastral plans and maps are digitized manually (with digitizers) or semi-automatically (with scanners). The most common problems are:

- difficulties in accessing the cards;
- their content is not always up to date at the time of digitization;
- poor compatibility between cards issued in different years;
- inaccuracies in the maps;
- paper maps are easily deformed (shrunken or stretched) and wasted, which leads to the introduction of inaccurate coordinates of digitized points;
- the cards themselves contain errors that are automatically transmitted to their digital counterpart;
- It is often difficult to reconcile the edges of adjacent map sheets.
- In the process of digitization, operators make a number of mistakes, the most typical of which are the following:
- crossing the lines;
- duplication of objects;
- disconnection of lines;
- wrong registration, etc.

2.3. Geodetic measurements (including non-compliance with Articles 36 and 38 of CPRA)

2.3.1. Requirements for geodetic measurements

The requirements for performing geodetic measurements when creating a cadastral map and cadastral registers, acCRding to [44], are:

1. The geodetic measurements shall be carried out by means of technologies, which provide data for determination of geodetic coordinates of points from borders, with accuracy, higher than the one determined in art. 18, para. 4, item 1, letter "a", respectively - Art. 18, para. 5, item 1, letter "a" of [44], reduced three times.

2. The technologies for determining the coordinates of points by digitization (scanning and vectorization) of graphic plans and maps approved by law are not geodetic measurements.

3. Geodetic measurements may be performed by:

(a)total stations and technologies ensuring high accuracy;

(b) GNSS and technologies to ensure the accuracy specified in [44];

(c)photogrammetric technologies ensuring sufficiently high accuracy;

(d) combinations of the listed

5. Geodetic measurements with GNSS for determination of geodetic coordinates of border points are performed in acCRdance with the requirements of Instruction № RD-02-20-25 of 2011 for determination of geodetic points with the help of global navigation satellite systems.

6. The requirements of Ordinance № RD-02-20-16 of 2011 shall be applied for determination of geodetic coordinates of points of boundaries by photogrammetric technologies.

To assess the accuracy of geodetic measurements in our country it is accepted to use the method of least squares, which is developed independently of Gauss and Lojander.

The specific geodetic activities in the creation and control of the cadastre are a variant of a geodetic photograph.

2.3.2. Marking property boundaries acCRding to Art. 36 and Art. 38 of the CPRA

AcCRding to Art. 36 of the CPRA, the regional governor and the mayor of the municipality shall be obliged to ensure the demarcation of the boundaries of the state and municipal properties within the term specified in the order under Art. 35, para. 1, and to provide to AGCC data for the real estates from the respective registers.

AcCRding to Art. 38 CPRA, the owner, respectively the holder of another real right, is obliged:

1. To provide free access to the property for cadastral works;
2. To mark with permanent signs the borders of his property and to protect the signs from destruction;
3. To present to an employee of the service of geodesy, cartography and cadastre upon request an act certifying his rights over the property;
4. To protect the geodetic signs placed in the property.

2.3.3. Errors in performing geodetic measurements and non-compliance with Art. 36 and Art. 38 of the CPRA

- the property was not photographed at all as an independent land property in the cadastral map;
- a real part of a land property has been wrongly photographed within the boundaries of another land property;
- the wrong survey in the cadastral map of the boundaries of a real estate land, the outlines of a building and a separate object.
- as a result of old ownership documents provided, for example before division, merger or expropriation procedures.

2.4. Consolidation of data from different sources (including contact area)

2.4.1. Establishment and maintenance of the CMCR for the non-urbanized territories

Acceleration of the process of establishing CMCR for the territory of the whole country is realized by elaborating CMCR for the non-urbanized territory, using the data from MRP.

In the practice of AGKK - in the process of establishing the CMCR and keeping the already approved CMCR up-to-date, discrepancies are found in the non-urbanized territory, which have been transferred to CMCR by MRP. When establishing the CMCR, discrepancies are found only within the boundaries of the contact zone between the urbanized and non-urbanized territory. Their removal is regulated by the CPRA and the LGAA.

When maintaining the CMCR, the discrepancies in the non-urbanized territory are found incidentally - on the occasion of specific applications from individual stakeholders. In most cases, the identified discrepancies are inaccurate or missing topographic sites of natural or artificial origin - rivers, ravines, roads, technical infrastructure.

2.4.2. MRP analysis before the establishment of the CMCR [33]

The assessment of the accuracy and content was performed on the basis of the identified discrepancies in the location of linear and area objects of anthropogenic and natural origin, reflected in MRP.

2.4.3. Consolidation of data from different sources

When combining (merging) maps, plans and other documentation approved under the Law on Land Acquisition and Use, the Land Use Planning Act and the repealed ZEKNRB and ZTSU, as well as the data collected through geodetic, photogrammetric and other measurements and calculations around the construction boundaries of settlements or discrepancies in land properties.

2.4.4. Construction boundaries of settlements [27]

he construction boundaries of the settlements are determined by a plan for regulation (PR), a plan for construction (PA), a plan for regulation and construction (PR) or with a ring polygon. The identification of the construction boundaries is performed by a qualified person acCRding to the cadastre on the original of the valid approved PPP or on the map material on which the ring polygon is determined (drawn).

2.4.5. Making a map of the contact area [27]

The map of the contact zone is a combined image of the data on the boundaries of the properties, obtained from sources under Art. 36, para. 1 and from geodetic measurements and calculations of materialized boundaries in the territory of the contact zone.

In case of overlapping data for land properties from the map of the restored property and the cadastral map, those obtained through direct geodetic measurements are considered CRrect, as the areas comply with the ownership documents.

2.4.6. Minimum allowable areas and sizes in the formation of land properties [27]

The minimum sizes of land are as follows:

1. For a non-urbanized area:
    - 3 decares for the fields;
    - 2 decares for the meadows;
    - 1 decare for vineyards, orchards and perennials.
2. For an urban area with low-rise housing [25]:

- In cities - at least 14 m face and 300 m2 surface;
- In the resort settlements and settlement formations and in the resort zones of the settlements - at least 16 m face and 500 m2 surface;

- In the villa areas - at least 18 m face and 600 m2 surface;
- In the villages or parts of them with predominant flat terrain - at least 16 m face and 500 m2 surface, and in specific terrain and economic conditions, as well as on main streets - at least 14 m face and 300 m2 surface;
- In villages or parts of them with predominantly steep terrain - at least 12 m face and 250 m2 surface.

2.4.7. List of affected properties [27]

A list (register) of the affected properties is prepared for the map of the contact zone, which contains:

1. The identifiers (old and new) of the affected land properties;
2. The names and addresses of the owners;
3. The area of the properties from the map of the restored property;
4. The area of the cadastral map;
5. The area for compensation.

2.4.8. Materials and data provided by the contractor for the contact area

1. Explanatory note;
2. Map of the contact zone, obtained by combining the data contained in maps, plans, registers and other documentation approved under the Spatial Development Act, the Land Use Planning Act, the Land Use Planning Act and the repealed ZEKNRB and ZTSU;
3. Map of the contact area with the contractor's proposals for elimination of the discrepancies;
4. Excerpt from the cadastral map and the cadastral register of the real estates for the contact zone after adjusting the borders of the land properties;
5. List of affected properties.
6. All data and materials are presented in digital and textual, respectively graphic form.

2.4.9. Acceptance of the contact area

The map of the contact zone and the list of the affected properties shall be considered by a commission under Art. 47, para. 1 [14]. The decisions of the commission shall be reCRded in the minutes. The competent person shall adjust the boundaries of the properties from the contact zone acCRding to the

protocol before the acceptance of the cadastral map and the cadastral registers by the order of art. 45 [14].

2.5. Influence of the multi-cadastral map on the users of cadastral data

he accuracy of the cadastral map is determined in acCRdance with Article 18 of [44] as the CRrespondence of the data for the real estates, which existed at the moment of approval of the map acCRding to their actual condition.

The accuracy of the land properties, buildings and facilities of the technical infrastructure listed in the cadastral map is determined by calculating the values of:

1. The error in the absolute position of a detailed point (ΔS);
2. The error in the distance between two detailed points (∂S).

By "error in the absolute position of a detailed point" is meant the quantity:

(2.65) $$\Delta S = \sqrt{(x - x_0)^2 + (y - y_0)^2},$$

where:

xo, yo are the coordinates of the point in the cadastral map;

x, y - the coordinates of the identical point in the control determination by geodetic measurement and calculation in the coordinate system of the cadastral map.

By "error in the distance between two detailed points" is meant the quantity:

$$\partial S = S - So,$$

where:

So is the distance between two randomly selected detailed points in one or adjacent sites (land properties, buildings or facilities of the technical infrastructure) of the plan or map;

S - the distance during the control measurement on site between the identical detailed points.

The permissible difference in the area determined after the control measurement of the points from the boundaries of a land property or building is calculated acCRding to the formula:

(2.66) $$m_{p_{доп.}} = 2\Delta S\sqrt{P},$$

- where:
- ΔS is a quantity that depends on the accuracy of the coordinates of the boundary points of the property in m;
- P - the area of the property in m2.
- The multi-cadastral map affects:
- - the accuracy of the reflection of the individual objects;
- - accuracy in defining boundaries;
- - the accuracy in determining the areas;
- - wrong assessment of the building.

Conclusions and summaries to Chapter Two

Based on the literature review and its analysis of the sources of errors in the integrated cadastral map, the following conclusions can be drawn:

1. The different types of coordinate systems and their implementations in our country are analyzed.

2. The use of different coordinate systems over the years affects the accuracy of the transformed cadastral plans and maps from one coordinate system to another.

3. A multi-class geodetic basis has been created in Bulgaria, as the accuracy of each class is different and it affects the accuracy of each subsequent class. This circumstance is often overlooked.

4. When digitizing the cadastral plans, gross errors are made by the operators, which affect the accuracy of the digital model of the cadastral map.

5. The non-fulfillment of the obligations of the executive power and the owners leads to incompleteness and errors in the cadastral map.

6. The contact zone is an overlap (overlap) of land properties or obtaining empty spaces (white spots) between them;

Chapter three. METHODOLOGY FOR EVALUATION OF THE EFFICIENCY OF INTEGRATING THE CADASTRAL MAP WITH A MAP OF THE RESTORED PROPERTY ON THE TERRITORY OF THE REPUBLIC OF BULGARIA

3.1. Strategic analysis of the integrated cadastral map and cadastral registers

The integrated cadastral map and cadastral registers are a complex set of elements that: form a whole (have a structure); are interconnected; interact to achieve a specific goal.

Preparation of strategic analysis - of the internal and external environment is achieved with SWOT analysis.

3.2. Criteria for evaluating the effectiveness of the integrated cadastral map and cadastral registers

A system of criteria has been proposed, which should be considered open. It can be supplemented with new criteria, as well as excluding some existing ones, depending on the specific objectives. In this case, the following groups of criteria are defined:

- Accuracy;
- Up-to-date data;
- Content;
- Truthfulness of the data.

3.3. Methodology for evaluating the effectiveness of the integrated cadastral map and cadastral registers

3.3.1. Methodology for transforming map materials from one coordinate system to another and determining areas

The transformation of the map materials from one coordinate system to another goes through several stages:

1. The Mkad software product is used for this purpose. The map is loaded, which is in digital form and in a coordinate system in 1970.
2. The coordinates of the coordinate crosses at at least four points shall be reported.
3. The official software of the Agency for Geodesy, Cartography and Cadastre - BGSTrans is used for transformation of the coordinates from CS 1970 into coordinate system BGS 2005 (Cadastral)..

4. After the coordinates of the points are transformed, in the Mkad environment, an affine transformation of the map image is performed.

5. Consecutively, for each coordinate cross, the coordinates are entered in CS 1970 and CS BGS 2005 (Cadastral).

6. After the transformation of the map image, the area of the different objects is calculated.

In this case the area of the objects - land properties is calculated by the planes (rectangular coordinates) in the following order:

- the CRner points of the landed property are numbered clockwise;
- the rectangular coordinates (X, Y) of all points are determined;
- acCRding to formulas (3.2) the area of the figure is calculated (for control acCRding to both formulas):

(3.2) $$2P = [Y_i.(X_{i-1} - X_{i+1})]; \qquad 2P = [X_i.(Y_{i+1} - Y_{i-1})]$$

To more accurately determine the area of the selected object, the coordinates of the points defined in two different ways are used.

3.3.2. Methodology for establishing an obvious factual error

An obvious factual error is established when the differences ΔSi under Art. 18, para. 5 of Ordinance № RD-02-20-5 of 15.12.2016, between identical points of the boundaries of the properties on the map of the restored property and those determined by geodetic measurements do not meet the accuracy requirements of Chapter 2, point 1.2 .1. Establishment of a manifest factual error, p. 27.

3.3.2.1. Establishing a manifest factual error

The initial establishment of YAFG is done with the help of cadastral-administrative information system / CAIS /, available on the website of AGCC. (Fig. 3.1)

Fig. 3.1. Cadastral map in KAIS environment

To fulfill the goal through KAIS, the layers visualizing the objects from the cadastral map with the aerial photos are combined. (Fig. 3.2 and Fig. 3.3)

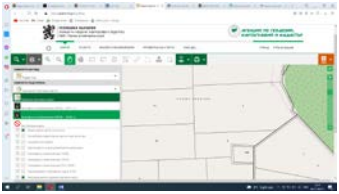

Fig. 3.2. Cadastral map based on administrative map

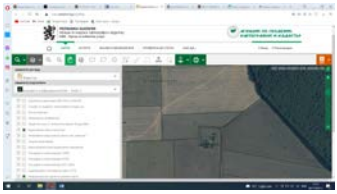

Fig. 3.3. Cadastral map based on aerial image

The system allows for combining other types of data available in the database, such as satellite topographic, administrative-territorial and others. Video tutorials are provided for the users of the system to get acquainted with and master the possibilities of the system.

In order to confirm the initially identified cases of MFE, we also combine the cadastral map with the satellite images provided by Google Earth. For this purpose, the MKAD software product and pre-launched on the Google Earth computer is used. The procedure is performed in the following order:

1. The respective land for which there are pre-designated MFE is loaded (Fig. 3.4).

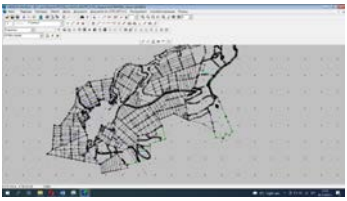

Fig. 3.4. Cadastral map in Mkad environment

2. From the menu "Edit" indicate "Select rectangle" and use the mouse to specify the area of cadastral objects to be selected (Fig. 3.5).

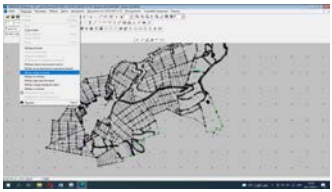

Fig. 3.5. Cadastral map in Mkad environment

3. From the additional menu select "inside" and thus the selected objects are marked on the screen (Fig. 3.6).

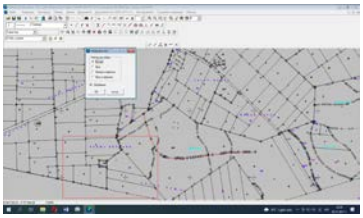

Fig. 3.6. Cadastral map in Mkad environment

4. In the same menu "Edit" the option "Favorites in Google Earth" is used (Fig. 3.7).

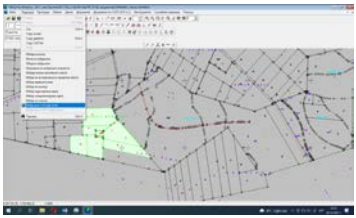

Fig. 3.7. Cadastral map in Mkad environment

As a result, the boundaries of all selected objects are visualized on the virtual earth's surface, composed of satellite images (Fig. 3.8).

Fig. 3.8. Cadastral map in Google Earth environment

The procedure described above is performed for each land and is compared with the pre-determined cases of MFE.

After comparing the data from CAIS and Google Earth with the cadastral map, it is established that the pre-identified cases of MFE are confirmed and the scope of the sites affected by MFE and geodetic measurements can be determined..

3.3.2.2. Determining the scope of the affected properties

Due to the fact that at this stage geodetic measurements of the sites have not been performed yet, as well as the exact CRrespondences / discrepancies / in the accuracy of reCRding the objects in the cadastre have not been determined, the determination of specific properties affected by MFE may be incomplete or excessive. However, for the needs of the assignment of a project for amendment of the CMCR for removal of MFE it is enough, as the discrepancy between the reflected objects of the cadastre in KK and their actual situation is serious and much bigger than the admissible.

3.3.2.3. Performing geodetic measurements in case of obvious factual error

Geodetic measurements are performed in compliance with the requirements of Instruction № RD-02-20-25 of 20 September 2011 on the determination of geodetic points using global navigation satellite systems, the Road Act, the Water Act, the Railway Transport Act, Forest Act.

Measurements for different objects (linear or area) have their own characteristics.

3.3.2.4. Elaboration of a project for amendments to the CMCR

The obvious factual error is eliminated on the basis of a project for amendment of the cadastral map and the cadastral register of the real estates, made by a qualified person, on assignment by AGCC or by an interested person. The law requires that the scope of this project include all land properties affected by the identified error.

3.3.3. Methodology for identifying incompleteness and errors

3.3.3.1. Identification of incompleteness and errors

Step 1: The initial identification of incompleteness and errors is done with the help of the cadastral-administrative information system / CAIS /, available on the website of AGCC (Fig. 3.9).

To fulfill the goal through KAIS, the layers visualizing the objects from the cadastral map with the aerial photos are combined.

Step 2: After finding incompleteness and errors in a cadastral map, geodetic measurements of cadastral objects / property boundaries, contours of buildings or individual objects / are performed..

Step 3: After processing the measurements are compared with the cadastral map and checked for deviations in the position between the measured and indicated in the map points.

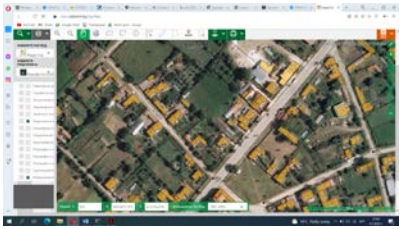

Fig. 3.9. Cadastral map of an urbanized area in the KAIS environment

3.3.3.2. Performing geodetic measurements

To confirm the presence of incompleteness or error in the cadastral map, geodetic measurements are performed (geodetic photograph of the property). Surveying is usually performed by the polar method with a total station, but if possible it can also be measured using GNSS real-time measurements.

3.3.3.3. Elaboration of a project for elimination of incompleteness and errors

The project for the elimination of incompleteness and errors is made by a qualified person, at the initiative of the owner.

The Cadastre Office checks the project and issues a certificate for accepted project.

The map is CRrected in acCRdance with the measurements made.

3.4. Technology of application of the methodology

3.4.1. Purpose of the methodology

The methodology aims to regulate and determine the study of the state and degree of effectiveness of the integrated cadastral map and cadastral registers in the Republic of Bulgaria: goals and objectives of the assessment; subject and object of evaluation; types of assessment; periodicity; evaluation criteria / scope /, indicators to the criteria.

3.4.2. Subject of the methodology

In acCRdance with the requirements of the Law on Cadastre, Property Register (CPRA) and other normative documents in AGCC, the study is committed to establishing the quality and effectiveness of data in the integrated cadastral map and cadastral registers.

3.4.3. Scope of the methodology

The requirements of the methodology should be applied to the central and regional structures of AGCC, the surveying companies involved in the development and maintenance of CC and CR and users of services and data..

3.4.4. Rules of execution:

- Identification of discrepancies;
- Performing geodetic measurements;
- Information processing;
- Preparation of a draft amendment to the CMCR;
- Presentation of the draft amendment to the CMCR.

Conclusions and summaries to Chapter Three

1. For strategic analysis of the integrated cadastral map and cadastral registers the SWOT analysis of the strengths and weaknesses of the integrated cadastral map is used.

2. A system of criteria for evaluating the effectiveness of the integrated cadastral map for the cadastre has been developed and proposed.

3. A methodology has been developed to study the effectiveness of integrating the cadastral map with the map of the restored property with private methodologies for transformation of map materials from one coordinate system to another, to establish obvious factual error and to identify incompleteness and errors.

4. The requirements for performing geodetic measurements for different sites in different situations are indicated.

Chapter four. EXPERIMENTAL RESEARCH ON THE EFFICIENCY OF INTEGRATING THE CADASTRAL MAP WITH A MAP OF THE RESTORED PROPERTY ON THE TERRITORY OF THE REPUBLIC OF BULGARIA

4.1. Presentation of the results of research of the used coordinate systems in the creation of the integrated cadastral map

The problems for transformation of data from the coordinate system 1970 to the Bulgarian Geodetic System 2005 (BGS2005) and their impact on the areas of landfill sites are considered. The admissible errors in the repeated (control) measurement of the area of the land property are:

(4.1.) $$mP_{\text{доп.}} = 2\,\partial S\sqrt{P}$$

❖ The first case considered is for the land of the village of Naum, Kaolinovo municipality, Shoumen district. For the transformation, 16 points (coordinate crosses) were used, evenly distributed throughout the land. The coordinates of the points in CS 1970 and their transformed coordinates in BGS 2005 are given in Table 4.1.

Table 4.1 Coordinates of the points in CS 1970 and their transformed coordinates in BGS 2005

№	X KS 1970	Y KS 1970	X BGS 2005	Y BGS 2005
1	4731500,000	9566000,000	4833644.457	621324.957
2	4730000,000	9566000,000	4832144.408	621337.693
3	4728500,000	9566000,000	4830644.365	621350.430

4	4727000,000	9566000,000	4829144.327	621363.166
5	4731500,000	9568000,000	4833661.434	623325.027
6	4730000,000	9568000,000	4832161.385	623337.756
7	4728500,000	9568000,000	4830661.342	623350.485
8	4727000,000	9568000,000	4829161.304	623363.213
9	4731500,000	9570000,000	4833678.402	625325.097
10	4730000,000	9570000,000	4832178.353	625337.818
11	4728500,000	9570000,000	4830678.309	625350.539
12	4727000,000	9570000,000	4829178.272	625363.261
13	4731500,000	9572000,000	4833695.359	627325.166
14	4730000,000	9572000,000	4832195.310	627337.880
15	4728500,000	9572000,000	4830695.267	627350.594
16	4727000,000	9572000,000	4829195.229	627363.308

The affine transformation took place in the Mkad environment. The errors in X and Y are shown in fig. 4.1.

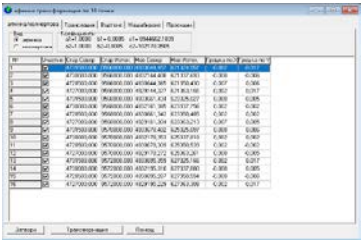

Fig. 4.1. X and Y errors in affine transformation

Three permanent sites have been selected - land properties, sanitary protection zone belt "A" with identifier 51158.33.368 and two cemetery parks with identifiers respectively 51158.25.327 and 51158.24.328, located in the land of the village.

- The differences in the coordinates and in the absolute position for the first site, sanitary protection zone belt "A" with identifier 51158.33.368 (Fig. 4.2.), Are given in Table 4.2, and the differences in area are given in Table 4.3.

Fig. 4.2. Sanitary protection zone belt "A" with identifier 51158.33.36, located in the village of Naum

Table 4.2 Differences in coordinates and in the absolute position of the points

№ on the CRners of the property	Reported coordinates BGS 2005		Measured coordinates BGS 2005		Differences		
	X (m)	Y (m)	X (m)	Y (m)	dx (m)	dy (m)	ds (m)
1	4830274,980	622205,000	4830252,190	622190,572	-22,794	-14,428	26,977
2	4830278,410	622149,000	4830256,176	622151,905	-22,230	2,905	22,419
3	4830233,730	622151,000	4830224,151	622151,003	-9,576	0,003	9,576
4	4830232,280	622206,000	4830219,696	622187,232	-12,585	-18,768	22,597

Table 4.3 Differences in area

Area			Differences		
1970 г. (m^2)	BGS 2005. Cadastral map (m^2)	BGS 2005. Geodetic measurements (m^2)	1 (1-2) (m^2)	2 (3-2) (m^2)	3 (3-1) (m^2)
1	2	3	4	5	6
2409,340	2410,000	1216,989	-0,660	-1193,010	-1192,350

Using formula (4.1), the permissible differences are calculated:

$$mP_{доп.} = 2\Delta S\sqrt{P} = 2 * 1.20 * \sqrt{1216,989} = 83,725\ m^2$$

The permissible value for the first site is 83,725 m^2, the difference obtained in the area after geodetic measurements is 1193.01 m^2, which is significantly higher than the permissible value.

- The differences in coordinates and in the absolute position for the second site, cemetery park with identifier 51158.25.327 (Fig. 4.3), are given in Table 4.3, and the differences in area are given in Table 4.5.

Fig. 4.3. Cemetery park with identifier 51158.25.327, located in the village of Naum

Table 4.4 Differences in coordinates and in the absolute position of the points

№ on the CRners of the property	Reported coordinates BGS 2005		Measured coordinates BGS 2005		Differences		
	X (m)	Y (m)	X (m)	Y (m)	dx (m)	dy (m)	ds (m)
1	4830797,590	623225,000	4830796,718	623224,352	-0,876	-0,648	1,090
2	4830720,850	623174,000	4830720,775	623174,142	-0,077	0,142	0,162
3	4830751,140	623126,000	4830751,878	623126,662	0,737	0,662	0,991
4	4830794,990	623048,000	4830794,617	623048,384	-0,375	0,383	0,537
5	4830908,140	623100,000	4830908,399	623100,707	0,258	0,707	0,752

Table 4.5 Differences in area

Area			Differences		
1970 г. (m^2)	BGS 2005. Cadastral map (m^2)	BGS 2005. Geodetic measurements (m^2)	1 (1-2) (m^2)	2 (3-2) (m^2)	3 (3-1) (m^2)
1	2	3	4	5	6
16565,570	16568,000	16382,337	-2,430	-185,663	-183,233

Using formula (4.1), the permissible differences are calculated:

$$P_{доп.} = 2\Delta S\sqrt{P} = 2 * 1{,}20 * \sqrt{16382{,}337} = 307{,}184\ m^2$$

The permissible value for the second site is 307,184 m^2, and the difference obtained in the area after geodetic measurements is 185,663 m^2, which is less than the permissible value.

- The differences in the coordinates and in the absolute position for the third site, cemetery park with identifier 51158.24.328 (Fig.4.3), are given in Table 4.6, and the differences in the area are given in Table 4.7.

Fig.4.3. Cemetery park with identifier 51158.24.328, located in the village of Naum

Table 4.6 Differences in coordinates and in the absolute position of the points

№ on the CRners of the property	Reported coordinates BGS 2005		Measured coordinates BGS 2005		Differences		
	X (m)	У (m)	X (m)	У (m)	dx (m)	dy (m)	ds (m)
1	4830966,640	623112,000	4830961,022	623113,516	-5,619	1,516	5,820
2	4830978,480	623128,000	4830980,969	623133,976	2,485	5,976	6,472
3	4831032,710	623119,000	4831028,988	623110,155	-3,723	-8,846	9,597
4	4831021,730	623074,000	4831021,631	623074,255	-0,103	0,255	0,275
5	4831001,350	623076,000	4830995,009	623079,572	-6,343	3,572	7,279

Table 4.7 Differences in area

Area			Differences		
1970 г. (m^2)	BGS 2005. Cadastral map (m^2)	BGS 2005. Geodetic measurements (m^2)	1 (1-2) (m^2)	2 (3-2) (m^2)	3 (3-1) (m^2)
1	2	3	4	5	6
2193,220	2212,540	2322,640	-19,320	110,100	129,220

Using formula (4.1), the permissible differences are calculated:

$$P_{доп.} = 2\Delta S\sqrt{P} = 2 * 1{,}20 * \sqrt{2322{,}640} = 115{,}665 \text{ m}^2$$

The permissible value for the third site is 115,665 m^2, and the difference obtained in the area after geodetic measurements is 110,100 m^2, which is less than the permissible value.

In the same way the lands of the village of Izgrev, municipality of Venets, of the village of Takach and the town of Kaolinovo, municipality of Kaolinovo and of the village of Timarevo, municipality of Hitrino, located in Shoumen district and the land of Karapelit village, Dobrichka municipality, were transformed. Dobrich region. Geodetic measurements were performed on the sanitary protection zones belt "A" and cemetery parks located in Shumen district, and on a building for energy production (substation) located in Dobrich district. The results are given in tables of 4.8. to 4.20, accompanied by figures to the dissertation.

4.2. Presentation of the results of experimental research from the errors in the source map materials

In this point the different cases of MFE for the different sites are considered, the analysis of the accuracy of the existing map of the restored property acCRding to Ordinance RD 02-20-5 of 2016 is also made.

❖ The first considered case of YAFG is a road from the national road network with identifier 32562.18.534, located in the land of the village of Izgrev, Venets municipality, Shoumen district.

Step 1: In the CAIS, the road is visualized based on the aerial image (Fig.4.11).

Fig. 4.11. Road from the republican road network

Step 2: The land of the village of Izgrev is being loaded in the Moscow Ring Road. The path is selected and visualized in the Google Earth software product (Fig. 4.12).

Fig. 4.12. Road from the national road network in the Google Earth environment

After comparing the data from CAIS and Google Earth with the cadastral map, it is established that the pre-identified cases of MFE are reconfirmed and it is possible to proceed to determine the scope of sites affected by MFE and geodetic measurements.

Step 3: The properties affected by the MFE in the land of the village of Izgrev and the village of Kliment have the following identifiers: 32562.17.514, 32562.29.4, 32562.29.1, 32562.30.531, 32562.30.537, 32562.30.1, 32562.30.2 , 32562.18.532, 32562.18.622 and 32562.18.10.

Step 4: The geodetic measurements were performed in compliance with the requirements of Instruction № RD-02-20-25 of 20.09.2011 for determination of geodetic points with the help of global navigation satellite systems. The measurements were performed with a dual-frequency GNSS receiver Hi Target irtk 5 / horizontal accuracy 8 mm + 1 pmm; vertical accuracy 15 mm +1 pm RSM /.

In FIG. 4.13 shows the position of the points of the sites reflected in the CM and the points of the same sites as a result of geodetic measurements, in the area where the differences are greatest. The objects and their reflection in the CM are shown in black color and numbering, and those from the measurements are shown in red color.

Fig. 4.13

In the geodetic measurements of the road the detailed points subject to measurement are the points along the contour of the asphalt pavement, the benches, the ditches and the slopes.

GNSS measurements are given in Annex 1.

The performed geodetic measurements finally confirm the previously considered cases of MFE, selected by combining satellite images with a cadastral map.

AcCRding to para. 5 of Art. 18 of the same ordinance for non-urbanized territories are determined the allowable values of ΔS = 180 cm, in cases where the coordinates of the points in the cadastral map are determined by a graphic plan or map.

The compared points for performing the analysis of the site in the land of the village of Izgrev are a total of 64. The data are presented in Table 4.21.

Table 4.21 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	У (m)	X (m)	У (m)	
1	4829636,313	622105,010	4829636,328	622105,045	3,808
2	4829633,305	622097,289	4829639,198	622142,929	4601,888
3	4829649,522	622112,259	4829651,534	622145,283	3308,523
4	4829646,829	622116,494	4829651,413	622149,454	3327,724
5	4829642,737	622112,609	4829641,302	622149,540	3695,887
6	4829637,498	622108,051	4829637,318	622149,574	4152,339
7	4829631,733	622183,453	4829631,502	622183,415	23,410
8	4829615,323	622227,099	4829613,396	622226,134	215,512
9	4829598,535	622244,537	4829603,202	622246,933	524,611
10	4829571,263	622275,005	4829591,140	622279,946	2048,191
11	4829572,911	622329,354	4829579,851	622329,347	694,000
12	4829572,059	622352,654	4829571,710	622352,572	35,850
13	4829565,303	622392,610	4829565,706	622392,604	40,304
14	4829553,378	622450,688	4829559,623	622450,393	625,196
15	4829549,078	622509,220	4829549,510	622509,075	45,569
16	4829553,897	622510,141	4829554,729	622509,978	84,782
17	4829558,538	622451,359	4829564,109	622453,757	606,518
18	4829568,092	622403,769	4829568,646	622404,079	63,484
19	4829576,956	622353,309	4829577,203	622353,668	43,576
20	4829577,777	622333,791	4829583,235	622335,038	559,864
21	4829576,299	622276,268	4829595,997	622280,106	2006,842
22	4829601,080	622248,948	4829606,715	622251,889	635,631
23	4829625,452	622222,892	4829620,296	622222,376	518,176

24	4829636,124	622187,925	4829635,592	622187,732	56,593
25	4829617,544	622112,733	4829617,565	622112,778	4,966
26	4829618,674	622138,408	4829619,129	622138,363	45,722
27	4829614,077	622165,792	4829614,287	622165,868	22,333
28	4829611,145	622185,409	4829608,753	622184,984	242,946
29	4829602,971	622210,589	4829599,647	622210,349	333,265
30	4829587,967	622227,002	4829591,229	622227,751	334,689
31	4829593,110	622221,629	4829588,089	622232,387	1187,203
32	4829567,181	622222,658	4829573,991	622224,182	697,844
33	4829566,505	622227,668	4829568,826	622228,896	262,584
34	4829577,631	622229,511	4829581,801	622236,245	792,058
35	4829588,851	622226,140	4829585,777	622238,348	1258,907
36	4829549,893	622288,604	4829566,800	622290,990	1707,453
37	4829550,468	622295,542	4829565,787	622296,098	1532,909
38	4829550,946	622299,675	4829563,438	622299,241	1249,954
39	4829550,908	622303,885	4829558,156	622304,177	725,388
40	4829551,458	622311,120	4829556,677	622311,475	523,106
41	4829552,221	622348,339	4829555,153	622348,420	293,312
42	4829548,709	622370,894	4829551,347	622371,478	270,187
43	4829545,916	622387,696	4829546,649	622387,703	73,303
44	4829535,091	622440,179	4829542,929	622440,602	784,941
45	4829533,149	622468,887	4829538,298	622469,180	515,733
46	4829531,904	622488,886	4829533,723	622488,906	181,911
47	4829531,022	622495,309	4829531,679	622495,308	65,700
48	4829528,267	622512,197	4829529,118	622512,380	87,045
49	4829523,910	622511,646	4829524,173	622511,639	26,309
50	4829525,931	622496,635	4829526,815	622496,750	89,145
51	4829527,564	622485,399	4829530,300	622485,627	274,548
52	4829528,225	622463,491	4829534,359	622464,033	615,790
53	4829529,565	622442,298	4829537,544	622442,572	798,370
54	4829532,673	622425,287	4829538,898	622426,050	627,159
55	4829536,881	622405,203	4829539,773	622405,458	290,322
56	4829541,256	622385,412	4829542,980	622385,668	174,290
57	4829543,371	622372,857	4829546,958	622373,301	361,437
58	4829547,368	622344,167	4829550,491	622344,507	314,145
59	4829547,709	622327,936	4829551,094	622327,689	339,400
60	4829546,469	622310,758	4829551,698	622310,872	523,024
61	4829545,619	622301,432	4829553,573	622301,616	795,613
62	4829545,330	622294,268	4829561,103	622294,013	1577,506

63	4829544,819	622287,945	4829561,969	622289,648	1723,435
64	4829570,525	622236,028	4829579,601	622240,737	1022,489

All ΔS values greater than 180 cm are shown in red and represent 72% of the analyzed values.

As a result of the processing of the measurements for estimating the accuracy of the cadastral map, three statistical rows with values are obtained:

$$\Delta x_i = x_i - x_i^o$$

(4.2.)

$$\Delta y_i = y_i - y_i^o$$

$$\partial S_i = \partial S_i - \partial S_i^o$$

where the indications with a superscript "o" are values from the cadastral map, and the designations without a superscript are obtained as a result of geodetic measurements and processing.

The hypothesis for reconciling the empirical distribution with the normal one is tested by Pearson's test (χ2) and by calculating the asymmetry, excess and their respective confidence intervals.

Verification of consistency by Pearson 's test (χ2). 5 intervals from -∞ to + ∞ are selected. The normalized limits, the probability of falling and the theoretical and empirical number of errors are calculated. A study was made for gross and systematic errors. Measurements with gross errors are excluded from the study.

The results for the row ΔX are given in Table 4.22.

Таблица 4.22 Results for row ΔX

actual limits		standardized limits		probability of falling		number of errors		difference	$\Delta N_j^2/N_j$
bottom	upper	bottom	upper	F(tb)	F(tu) - F(tb)	theoretical	empirical	ΔN_j	χ^2_j
-∞	-2	0,000	-0,359	0,000	0,360	23,028	27,000	3,972	0,685
-2	0	-0,359	0,000	0,360	0,140	8,972	10,000	1,028	0,118
0	2	0,000	0,359	0,500	0,140	8,972	10,000	1,028	0,118
2	4	0,359	0,718	0,640	0,123	7,898	9,000	1,102	0,154
4	+∞	0,718	1,000	0,764	0,236	15,130	8,000	-7,130	3,360
			[ ]	1			64,000	χ^2=	3,74937

The total number of errors in the line ΔX is 64.

The degree of freedom is determined by the formula

(4.3.) $r = N - 3,$

where N is the number of intervals.

At a value of $\chi 2 = 3.74937$ and a degree of freedom of 2, the probability of 0.1534 was calculated. The calculated probability is greater than 0.1 and it can be argued that the hypothesis of a normal distribution of the studied order is confirmed.

The results for the row ΔY are given in Table 4.23

.

Table 4.23 Results for row ΔУ

actual limits		standardized limits		probability of falling		number of errors		difference	$\Delta N_j^2/N_j$
bottom	upper	bottom	upper	F(tb)	F(tu) - F(tb)	theoretical	empirical	ΔN_j	$\chi 2_j$
-∞	-2	0,000	-2,828	0,000	0,002	0,122	0,000	-0,122	0,122
-2	0	-2,828	0,000	0,002	0,498	25,873	35,000	9,127	3,219
0	2	0,000	2,828	0,500	0,498	25,883	14,000	-11,883	5,456
2	4	2,828	5,656	0,998	0,002	0,122	3,000	2,878	67,976
4	+∞	5,656	1,000	1,000	0,000	0,000	0,000	0,000	0,000
			[ ]	1			52,000	$\chi 2=$	76,6514

Due to gross errors, 12 measurements were excluded from the statistical list. The total number of errors in the order ΔU is 52.

The results for the order of δS are given in Table 4.24.

Table 4.24 Results for row δS

actual limits		standardized limits		probability of falling		number of errors		difference	$\Delta N_j^2/N_j$
bottom	upper	bottom	upper	F(tb)	F(tu) - F(tb)	theoretical	empirical	ΔN_j	$\chi 2_j$
-∞	-2	0,000	-2,391	0,000	0,008	0,386	1,000	0,614	0,975
-2	0	-2,391	0,000	0,008	0,492	22,614	18,000	-4,614	0,941
0	2	0,000	2,391	0,500	0,492	22,614	27,000	4,386	0,851
2	4	2,391	4,782	0,992	0,008	0,386	0,000	-0,386	0,386
4	+∞	4,782	1,000	1,000	0,000	0,000	0,000	0,000	0,000
			[ ]	1			46,000	$\chi 2=$	2,17845

Due to gross errors, 19 measurements were excluded from the statistical list. The total number of errors in the line δS is 46.

AcCRding to Appendix № 6 to Art. 82, para. 6 of [44] when more than 5% of the row values are excluded due to gross errors, the row analysis is terminated.

For the rows ΔY and δS the presence of gross errors exceeds 5% and the analysis for the rows ΔY and δS is terminated.

In conclusion, we can say that the lines ΔY and δS do not have a normal distribution.

The methodology for establishing an obvious factual error for the second site - local road Naum - Takach with identifier 51158.105.55, located on the land of the village of Naum, Kaolinovo municipality, Shoumen district is applied.

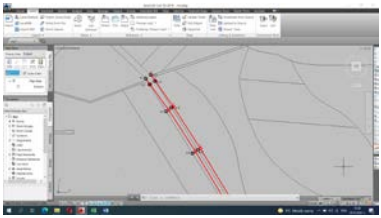

Fig. 4.16

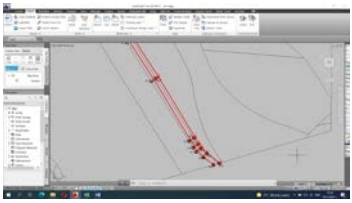

Fig. 4.17

The coordinates of all points are in the BGS 2005 coordinate system.

In the geodetic measurements of the road the detailed points subject to measurement are the points along the contour of the asphalt pavement, the benches, the ditches and the slopes.

GNSS measurements are given in Annex 1.

The performed geodetic measurements finally confirm the previously considered cases of MFE, selected by combining satellite images with a cadastral map.

AcCRding to para. 5 of Art. 18 of the same ordinance for non-urbanized territories are determined the allowable values of ΔS = 180 cm, in cases where the coordinates of the points in the cadastral map are determined by a graphic plan or map.

The compared points for performing the analysis of the site in the land of the village of Naum are a total of 18. The data are presented in Table 4.25.

Table 4.25 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	У (m)	X (m)	У (m)	
1	4830493,483	623552,411	4830493,456	623552,496	8,919
2	4830478,063	623562,329	4830478,649	623563,900	167,673
3	4830409,448	623606,506	4830412,696	623612,752	704,003
4	4830301,408	623675,985	4830305,997	623683,737	900,846
5	4830133,963	623783,822	4830136,760	623788,586	552,439
6	4830115,601	623795,624	4830118,216	623799,946	505,153
7	4830103,717	623803,530	4830106,235	623808,799	583,975
8	4830088,185	623825,276	4830089,319	623826,216	147,294
9	4830067,863	623853,803	4830067,097	623854,285	90,503
10	4830503,219	623565,248	4830503,286	623565,455	21,757
11	4830487,516	623576,524	4830487,691	623577,569	105,955
12	4830419,140	623620,115	4830421,385	623624,988	536,527
13	4830310,474	623689,519	4830314,104	623696,361	774,531
14	4830142,238	623796,989	4830144,628	623801,357	497,911
15	4830124,721	623808,151	4830126,607	623812,397	464,602
16	4830113,436	623815,651	4830116,138	623820,132	523,261
17	4830099,056	623834,190	4830100,609	623836,122	247,880
18	4830072,616	623869,224	4830071,889	623872,091	295,774

All values of ΔS larger than 180 cm are shown in red and represent 67% of the analyzed values.

❖ The methodology for establishing an obvious factual error for the third site - local road Naum - Kliment with identifiers 51158.1.112 and 37232.65.223, located in the land of the village of Naum and the village of Kliment, Kaolinovo municipality, Shoumen district.

In FIG. 4.21, Fig. 4.22, Fig. 4.23, Fig. 4.24 shows the position of the points of the sites reflected in the CM and the points of the same sites as a result of geodetic measurements, in the area where the differences are greatest. The objects and their reflection in the CM are shown in black color and numbering, and those from the measurements are shown in red color.

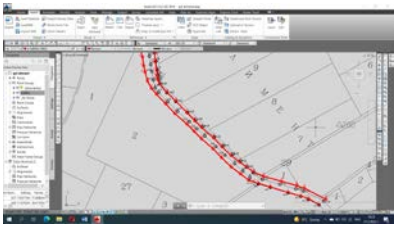

Fig. 4.21

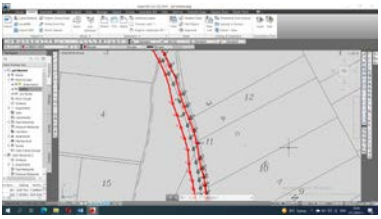

Fig. 4.22

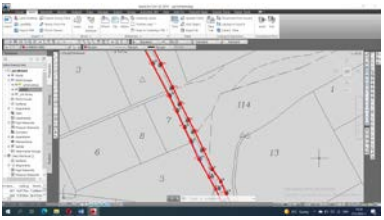

Fig. 4.23

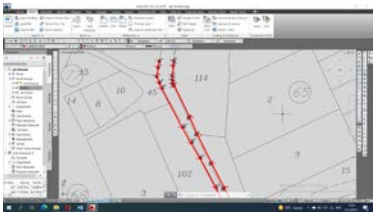

Fig. 4.24

The coordinates of all points are in the BGS 2005 coordinate system.

GNSS measurements are given in Annex 1.

The performed geodetic measurements finally confirm the previously considered cases of MFE, selected by combining satellite images with a cadastral map.

AcCRding to para. 5 of Art. 18 of the same ordinance for non-urbanized territories are determined the allowable values of ΔS = 180 cm, in cases where the coordinates of the points in the cadastral map are determined by a graphic plan or map.

The compared points for performing the analysis of the site in the land of the village of Naum and the village of Kliment are a total of 95. The data are presented in Table 4.26.

Table 4.26 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X	У	X	У	
1	4831626,108	622345,196	4831627,105	622344,994	101,726
2	4831635,452	622326,063	4831636,895	622326,747	159,690
3	4831640,753	622312,981	4831641,668	622313,399	100,596
4	4831646,958	622290,989	4831647,323	622291,287	47,120
5	4831655,840	622260,067	4831656,747	622260,182	91,426
6	4831661,847	622238,954	4831662,976	622239,620	131,080
7	4831672,978	622224,502	4831668,127	622223,076	505,625
8	4831683,784	622212,203	4831678,775	622208,381	630,062
9	4831696,562	622197,755	4831690,570	622192,101	823,843
10	4831711,399	622180,712	4831706,854	622174,772	747,935
11	4831726,110	622165,045	4831722,029	622160,199	633,548
12	4831743,915	622145,441	4831739,221	622139,835	731,169

13	4831756,580	622131,717	4831751,826	622127,100	662,701
14	4831768,700	622118,410	4831764,554	622114,239	588,103
15	4831786,392	622097,767	4831782,363	622093,152	612,626
16	4831802,739	622080,436	4831799,007	622076,866	516,456
17	4831818,548	622064,623	4831815,582	622060,644	496,282
18	4831826,410	622058,474	4831825,873	622051,968	652,812
19	4831839,988	622055,058	4831838,355	622044,743	1044,346
20	4831854,810	622052,457	4831853,652	622040,702	1181,190
21	4831866,476	622050,432	4831864,853	622038,295	1224,504
22	4831881,487	622047,965	4831880,268	622035,929	1209,757
23	4831896,037	622045,778	4831895,613	622031,113	1467,113
24	4831912,950	622042,195	4831910,618	622029,437	1296,938
25	4831937,098	622037,177	4831935,851	622027,164	1009,035
26	4831957,329	622031,628	4831956,262	622021,152	1053,020
27	4831979,549	622026,213	4831976,496	622014,268	1232,898
28	4832000,929	622019,017	4831998,521	622006,953	1230,197
29	4832023,222	622011,802	4832019,470	621999,116	1322,921
30	4832053,909	621999,988	4832052,441	621991,654	846,230
31	4832072,887	621991,151	4832071,237	621985,579	581,117
32	4832095,751	621980,641	4832094,536	621974,805	596,113
33	4832116,947	621967,945	4832115,577	621962,461	565,254
34	4832148,174	621946,203	4832147,332	621943,832	251,607
35	4832178,561	621931,366	4832180,264	621928,550	329,091
36	4832204,782	621919,015	4832204,346	621916,991	207,043
37	4832234,213	621905,011	4832233,632	621902,934	215,673
38	4832261,110	621891,565	4832260,388	621890,090	164,223
39	4832318,783	621861,076	4832317,957	621859,053	218,513
40	4832372,204	621831,717	4832371,672	621830,094	170,797
41	4832401,269	621815,916	4832399,365	621813,269	326,065
42	4832428,762	621800,278	4832427,763	621796,851	356,964
43	4832499,568	621760,593	4832498,869	621758,285	241,153
44	4832509,060	621755,259	4832508,651	621754,230	110,730
45	4832519,842	621749,429	4832519,902	621749,998	57,215
46	4832536,443	621752,287	4832536,838	621751,682	72,253
47	4832547,732	621754,231	4832548,128	621753,687	67,287
48	4831632,537	622352,850	4831636,222	622356,901	547,630
49	4831649,932	622317,601	4831655,161	622319,256	548,466
50	4831653,956	622304,308	4831659,626	622305,733	584,633
51	4831661,548	622276,607	4831666,757	622279,581	599,820

52	4831669,976	622246,009	4831675,391	622248,058	578,970
53	4831681,747	622229,853	4831682,267	622230,937	120,227
54	4831691,059	622219,028	4831690,713	622218,631	52,662
55	4831700,937	622207,865	4831699,436	622206,592	196,813
56	4831712,815	622194,505	4831710,482	622191,344	392,872
57	4831727,568	622178,124	4831725,543	622175,319	345,957
58	4831742,295	622162,046	4831741,102	622160,378	205,072
59	4831760,485	622142,173	4831758,458	622139,819	310,645
60	4831771,871	622129,518	4831770,506	622127,646	231,681
61	4831784,513	622115,162	4831783,790	622114,223	118,509
62	4831803,264	622094,449	4831803,628	622095,056	70,777
63	4831818,315	622078,970	4831818,635	622079,491	61,143
64	4831833,700	622067,253	4831833,752	622065,690	156,386
65	4831841,513	622065,457	4831841,065	622062,438	305,206
66	4831848,480	622063,778	4831848,131	622061,840	196,917
67	4831857,301	622062,082	4831857,182	622061,016	107,262
68	4831872,476	622059,537	4831872,266	622058,272	128,231
69	4831887,094	622057,364	4831887,077	622056,900	46,431
70	4831902,920	622054,647	4831902,436	622051,411	327,200
71	4831921,267	622050,852	4831920,812	622047,843	304,321
72	4831948,056	622044,624	4831947,799	622043,160	148,639
73	4831970,777	622038,927	4831970,379	622036,978	198,922
74	4831993,183	622032,565	4831992,230	622028,614	406,431
75	4832014,791	622025,137	4832013,897	622019,557	565,116
76	4832036,794	622018,015	4832035,839	622012,421	567,493
77	4832066,990	622004,699	4832066,831	622003,090	161,684
78	4832087,519	621995,028	4832086,357	621992,836	248,095
79	4832107,647	621983,495	4832108,279	621984,035	83,128
80	4832129,562	621967,724	4832130,162	621968,749	118,770
81	4832163,289	621948,833	4832164,655	621952,585	399,293
82	4832195,775	621932,574	4832197,226	621936,664	433,976
83	4832216,089	621922,135	4832217,465	621925,987	409,039
84	4832245,556	621907,681	4832246,751	621910,243	282,699
85	4832273,976	621893,166	4832275,568	621896,717	389,154
86	4832315,282	621872,223	4832317,226	621875,447	376,475
87	4832361,188	621849,054	4832362,537	621851,805	306,395
88	4832414,333	621822,322	4832415,856	621824,787	289,754
89	4832444,889	621807,875	4832446,444	621810,535	308,117
90	4832503,659	621780,136	4832504,308	621781,911	188,993

91	4832507,695	621778,234	4832507,945	621779,365	115,830
92	4832514,451	621777,898	4832514,449	621778,192	29,401
93	4832522,051	621777,671	4832522,020	621777,770	10,374
94	4832540,733	621779,439	4832540,674	621779,981	54,520
95	4832549,060	621780,277	4832549,066	621780,636	35,905

All ΔS values greater than 180 cm are shown in red and represent 68% of the analyzed values.

The hypothesis for reconciling the empirical distribution with the normal one is tested by Pearson's test (χ2) and by calculating the asymmetry, excess and their respective confidence intervals.

Verification of consistency by Pearson 's test (χ2). 5 intervals from -∞ to + ∞ are selected. The normalized limits, the probability of falling and the theoretical and empirical number of errors are calculated. A study was made for gross and systematic errors. Measurements with gross errors are excluded from the study.

The results for the order ΔX are given in Table 4.27.

Table 4.27 Results for row ΔX

actual limits		standardized limits		probability of falling		number of errors		difference	$\Delta N_j^2/N_j$
bottom	upper	bottom	upper	F(tb)	F(tu) - F(tb)	theoretical	empirical	ΔN_j	χ^2_j
-∞	-2	0,000	-0,921	0,000	0,178	16,952	10,000	-6,952	2,851
-2	0	-0,921	0,000	0,178	0,322	30,548	42,000	11,452	4,293
0	2	0,000	0,921	0,500	0,322	30,548	30,000	-0,548	0,010
2	4	0,921	1,843	0,822	0,146	13,846	7,000	-6,846	3,385
4	+∞	1,843	1,000	0,967	0,033	3,106	6,000	2,894	2,697
			[ ]	1			95,000	χ^2=	13,2367

The total number of errors in the order ΔX is 95.

The degree of freedom is determined using the formula (4.3).

At a value of χ2 = 13.2367 and a degree of freedom of 2, the probability 0.0001 was calculated. The calculated probability is less than 0.1 and it can be argued that the hypothesis of a normal distribution of the studied order is not confirmed.

The results for row ΔY are given in Table 4.28.

Table 4.28 Results for row ΔУ

actual limits		standardized limits		probability of falling		number of errors		difference	$\Delta N_j^2/N_j$
bottom	upper	bottom	upper	F(tb)	F(tu) - F(tb)	theoretical	empirical	ΔN_j	χ^2_j
-∞	-2	0,000	-0,460	0,000	0,323	30,662	34,000	3,338	0,363
-2	0	-0,460	0,000	0,323	0,177	16,838	24,000	7,162	3,046
0	2	0,000	0,460	0,500	0,177	16,838	13,000	-3,838	0,875
2	4	0,460	0,920	0,677	0,144	13,677	11,000	-2,677	0,524
4	+∞	0,920	1,000	0,821	0,179	16,985	13,000	-3,985	0,935
			[ ]	1			95,000	$\chi^2=$	5,7434

The total number of errors in the order ΔU is 95.

Determine the degree of freedom for the order ΔY using formula (4.3.).

At a value of $\chi^2 = 5.7434$ and a degree of freedom of 2, the probability of 0.0566 was calculated. The calculated probability is less than 0.1 and it can be argued that the hypothesis of a normal distribution of the studied order is not confirmed.

The results for the order of δS are given in Table 4.29.

Table 4.29 Results for row δS

actual limits		standardized limits		probability of falling		number of errors		difference	$\Delta N_j^2/N_j$
bottom	upper	bottom	upper	F(tb)	F(tu) - F(tb)	theoretical	empirical	ΔN_j	χ^2_j
-∞	-2	0,000	-3,217	0,000	0,001	0,058	0,000	-0,058	0,058
-2	0	-3,217	0,000	0,001	0,499	44,440	47,000	2,560	0,147
0	2	0,000	3,217	0,500	0,499	44,444	42,000	-2,444	0,134
2	4	3,217	6,434	0,999	0,001	0,058	0,000	-0,058	0,058
4	+∞	6,434	1,000	1,000	0,000	0,000	0,000	0,000	0,000
			[ ]	1			89,000	$\chi^2=$	0,3395

Due to the presence of gross errors in the order of δS, 6 measurements are excluded from the statistical series. The total number of errors in the line δS is 89.

Determine the degree of freedom for the order of δS using formula (4.3.).

At a value of $\chi^2 = 0.3395$ and a degree of freedom of 2, the probability of 0.8439 was calculated. The calculated probability is greater than 0.1 and it can

be argued that the hypothesis of a normal distribution of the studied order is confirmed..

The results of the three tables give reason to believe that both rows have a distribution close to normal, and only one row confirms the hypothesis of normal distribution.

❖ The methodology for establishing a clear factual error for the fourth site - sanitary protection zone belt "A" with identifier 51158.33.368, located on the land of the village of Naum, Kaolinovo municipality, Shoumen district.

In FIG. 4.27 shows the position of the points of the sites reflected in the CM and the points of the same sites as a result of geodetic measurements, in the area where the differences are greatest. The objects and their reflection in the CM are shown in black color and numbering, and those from the measurements are shown in red color.

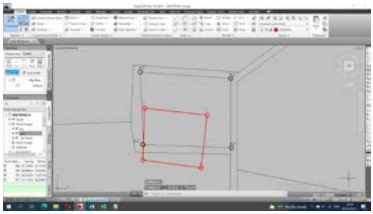

Fig. 4.27

The coordinates of all points are in the BGS 2005 coordinate system.

GNSS measurements are given in Annex 2.

The performed geodetic measurements finally confirm the previously considered cases of MFE, selected by combining satellite images with a cadastral map.

AcCRding to para. 5 of Art. 18 of the same ordinance for non-urbanized territories are determined the allowable values of $\Delta S = 180$ cm, in cases where the coordinates of the points in the cadastral map are determined by a graphic plan or map.

The compared points for performing the analysis of the site in the land of the village of Naum are 4 in total. The data are presented in Table 4.30.

Table 4.30 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	У (m)	X (m)	X (m)	
1	4830274,980	622205,000	4830252,190	622190,572	2697,316
2	4830278,410	622149,000	4830256,176	622151,905	2242,297
3	4830233,730	622151,000	4830224,151	622151,003	957,900
4	4830232,280	622206,000	4830219,696	622187,232	2259,635

All ΔS values greater than 180 cm are shown in red and represent 100% of the analyzed values.

❖ The methodology for establishing an obvious factual error for the fifth site - field protection belt with identifier 27108.17.56, located on the land of the village of Ezerets, Shabla municipality, Dobrich district is applied.

In FIG. 4.30 shows the position of the points of the sites reflected in the CM and the points of the same sites as a result of geodetic measurements, in the area where the differences are greatest. The objects and their reflection in the CM are shown in black color and numbering, and those from the measurements are shown in red color.

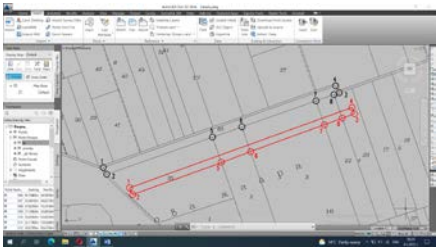

Fig. 4.30

The coordinates of all points are in the BGS 2005 coordinate system.

GNSS measurements are given in Annex 4.

The performed geodetic measurements finally confirm the previously considered cases of MFE, selected by combining satellite images with a cadastral map.

AcCRding to para. 5 of Art. 18 of the same ordinance for non-urbanized territories are determined the permissible values of ΔS = 180 cm, in cases where the coordinates of the points in the cadastral map are determined by a graphic plan or map.

The compared points for performing the analysis of the site in the land of the village of Ezerets are a total of 8. The data are presented in Table 4.31.

Table 4.31 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	Y (m)	X (m)	Y (m)	
1	4833316,313	743285,007	4833257,298	743362,921	9774,3
2	4833296,639	743295,452	4833237,645	743372,143	9675,4
3	4833540,651	743975,858	4833479,552	744020,675	7577,1
4	4833561,207	743965,063	4833498,121	744013,679	7964,1
5	4833407,951	743604,924	4833334,443	743631,268	7808,6
6	4833438,694	743691,022	4833366,314	743717,085	7693,2
7	4833516,517	743908,096	4833446,966	743933,056	7389,8
8	4833535,253	743960,457	4833466,429	743985,231	7315,5

All ΔS values greater than 180 cm are shown in red and represent 100% of the analyzed values.

In the latter case, in addition to the field protection zone, the object of the MFE is also an agricultural road that serves the belt and serves for access to part of the neighboring land properties. When drafting a project for the removal of MFE, it will be necessary to envisage a new agricultural road.

4.3. Results of the geodetic measurements, depending on the application of art. 36 and 38 of CPRA and their combination with data from existing plans and map

In this point the results of the geodetic measurements are considered, depending on the application of art. 36 and 38 of CPRA and their combination with data from existing plans and map.

❖ The first case considered is a wrongly drawn border in the cadastral map of the village of Kliment, Kaolinovo municipality, Shoumen district. The properties, between which there is a border, have identifiers 37232.501.485 and 37232.501.732.

Step 1: In the CAIS environment, a discrepancy of the boundary between the land properties with identifiers 37232.501.485 and 37232.501.732 was noticed (Fig. 4.31).

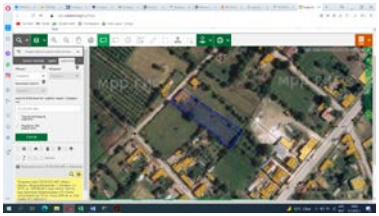

Fig. 4.31

Step 2: Geodetic measurements of land property with identifier 37232.501.485 were performed (Fig. 4.32).

Fig. 4.32

Step 3: After processing the measurements, they are compared with the cadastral map and checked for deviations in the position between the measured and indicated in the map points (Fig. 4.33).

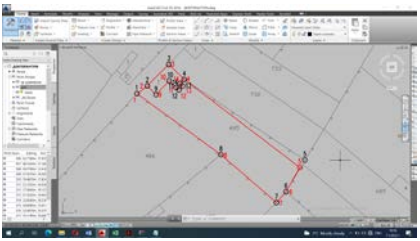

Fig. 4.33

The coordinates of all points are in the BGS 2005 coordinate system. The measurements are given in Appendix 5.

Since the boundary is not permanently materialized, the admissible value in the absolute position of the points is $\Delta S <= 60$ cm. After the analysis, a

difference greater than the allowable value was found at only one point. The higher than the allowable value is shown in red Table 4.32.

Table 4.32 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	Y (m)	X (m)	Y (m)	
1	4832997,064	621142,729	4832997,035	621142,718	3,095
2	4833001,235	621148,117	4833001,189	621148,163	6,484
3	4833012,589	621159,623	4833012,635	621159,579	5,791
4	4833004,560	621167,909	4833004,565	621167,937	2,868
5	4832961,767	621232,131	4832957,834	621229,487	473,909
6	4832944,909	621222,128	4832944,938	621222,102	3,905
7	4832939,145	621217,088	4832939,157	621217,084	1,253
8	4832964,662	621187,442	4832964,664	621187,452	1,099
9	4832996,567	621152,845	4832996,536	621152,856	3,255
10	4833003,895	621159,840	4833003,913	621159,809	3,587
11	4833000,356	621163,519	4833000,376	621163,487	3,774
12	4832999,078	621165,102	4832999,088	621165,129	2,888
13	4833001,128	621167,125	4833001,116	621167,147	2,489
14	4833002,458	621165,714	4833002,504	621165,716	4,615

❖ The methodology for establishing incompleteness and errors for the second case is applied - unpainted border between two plots of land in the cadastral map of the village of Kliment, Kaolinovo municipality, Shoumen district. The properties, among which is the missing boundary, have identifier 37232.501.592.

After processing the measurements, they are compared with the cadastral map and are checked for deviations in the position between the measured and indicated in the map points (Fig. 4.36).

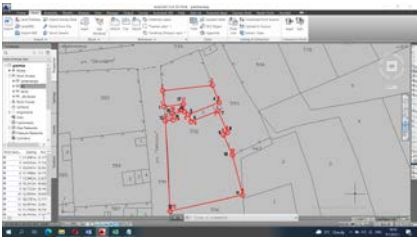

Fig. 4.36

The coordinates of all points are in the BGS 2005 coordinate system. The measurements are given in Appendix 6.

After the analysis it was found that all differences in the absolute position of the points are less than 6 cm, which is less than the allowable values for immaterial boundaries and for buildings of the main and ancillary buildings. It has also been established that there is an unpainted boundary of a land property with identifier 37232.501.592, the same is photographed with the detailed points number 2 and 3 of the geodetic survey, shown in the Figure in red. The results obtained after comparing the data from the cadastral map and those from the geodetic measurements are given in Table 4.33.

Table 4.33 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	Y (m)	X (m)	Y (m)	
1	4832465,175	621381,208	4832465,205	621381,246	4,852
2	-	-	4832474,733	621380,215	-
3	-	-	4832478,027	621410,025	-
4	4832467,729	621414,055	4832467,771	621414,026	5,121
5	4832460,393	621395,651	4832460,382	621395,631	2,247
6	4832456,179	621397,191	4832456,147	621397,145	5,604
7	4832462,635	621413,546	4832462,590	621413,543	4,531
8	4832449,688	621419,241	4832449,714	621419,236	2,622
9	4832448,184	621416,732	4832448,232	621416,743	4,928
10	4832436,048	621422,084	4832436,096	621422,111	5,521
11	4832412,171	621428,279	4832412,156	621428,311	3,557
12	4832402,403	621384,497	4832402,446	621384,492	4,324
13	4832456,758	621381,743	4832456,717	621381,782	5,630
14	4832457,315	621386,292	4832457,282	621386,318	4,193

15	4832461,263	621385,914	4832461,217	621385,876	5,974
16	4832462,244	621393,137	4832462,229	621393,187	5,246
17	4832466,645	621392,583	4832466,674	621392,631	5,584

❖ The methodology for establishing incompleteness and errors for the third case is applied - inCRrectly placed building in the cadastral map of the village of Kliment, Kaolinovo municipality, Shoumen district. The property in which the building is located has the identifier 37232.501.254.

After processing the measurements, they are compared with the cadastral map and are checked for deviations in the position between the measured and indicated in the map points (Fig. 4.39).

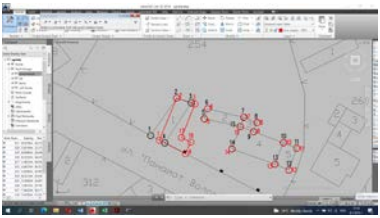

Fig. 4.39

The coordinates of all points are in the coordinate system BGS 2005. The measurements are given in Appendix 7.

As the building with discrepancies is from the additional construction, the admissible value in the absolute position of the points is ΔS <= 60 cm. After the analysis, a difference greater than the allowable value in three points was found. Larger values than allowed are shown in red Table 4.34.

Table 4.34 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	Y (m)	X (m)	Y (m)	
1	4833291,772	621436,527	4833290,510	621438,979	275,731
2	4833302,331	621443,858	4833302,375	621443,874	4,682
3	4833300,993	621447,934	4833300,646	621448,990	111,155
4	4833289,708	621440,516	4833286,676	621446,355	657,844
5	4833296,507	621451,615	4833296,442	621451,687	9,700

6	4833299,342	621452,580	4833299,357	621452,607	3,089
7	4833296,916	621462,759	4833296,985	621462,828	9,758
8	4833295,396	621466,473	4833295,446	621466,527	7,359
9	4833292,853	621465,567	4833292,891	621465,500	7,703
10	4833289,747	621473,937	4833289,796	621473,967	5,745
11	4833288,227	621477,710	4833288,171	621477,682	6,261
12	4833282,089	621475,487	4833282,030	621475,478	5,968
13	4833283,726	621471,597	4833283,684	621471,554	6,011
14	4833288,001	621459,453	4833288,059	621459,409	7,280
15	4833294,314	621461,793	4833294,289	621461,847	5,951
16	-	-	4833289,951	621447,853	-
17	-	-	4833291,234	621445,221	-

- The methodology for establishing incompleteness and errors for the fourth case is applied - an uninhabited building in the cadastral map of the village of Kliment, Kaolinovo municipality, Shoumen district. The property in which the building is located has identifier 37232.501.481.

After processing the measurements, they are compared with the cadastral map and checked for deviations in the position between the measured and indicated in the map points (Fig. 4.42).

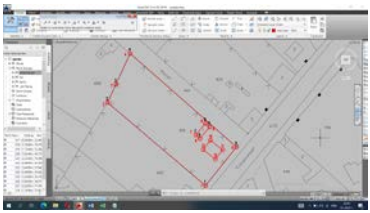

Fig. 4.42

The coordinates of all points are in the BGS 2005 coordinate system. The measurements are given in Appendix 8.

After the analysis, it was found that all differences in the absolute position of the points are less than 9 cm, which is less than the allowable values for immaterial boundaries and for buildings of the main and ancillary buildings. It was also established that there is an unpainted boundary in a land property with identifier 37232.501.481, the same was photographed with detailed points from number 10 to number 13 of the geodetic survey, shown in the Figure in red. The results obtained after comparing the data from the cadastral map and those from the geodetic measurements are given in Table 4.35.

Table 4.35 Differences in the absolute position of the points

№ at the point	Coordinates of the points of the CM		Coordinates of the measurement points		Differences ΔS (cm)
	X (m)	Y (m)	X (m)	Y (m)	
1	4832952,439	621330,496	4832952,444	621330,504	0,929
2	4833010,495	621261,830	4833010,478	621261,789	4,478
3	4833023,204	621267,682	4833023,269	621267,734	8,315
4	4833044,824	621277,636	4833044,779	621277,634	4,526
5	4832979,414	621352,253	4832979,398	621352,235	2,406
6	4832985,291	621326,606	4832985,251	621326,589	4,368
7	4832987,841	621323,612	4832987,840	621323,640	2,823
8	4832995,899	621330,450	4832995,942	621330,469	4,727
9	4832993,417	621333,376	4832993,418	621333,438	6,251
10	-	-	4832984,077	621333,946	-
11	-	-	4832977,439	621342,540	-
12	-	-	4832970,967	621337,400	-
13	-	-	4832977,605	621328,806	-

4.4. Presentation of the results of the study of the aggregated data from different sources (including the contact area)

The data from the cadastral map of the urbanized territory and from the cadastral map of the non-urbanized territory for the land of the village of Zograf, General Toshevo municipality, district Dobrich

A map of the contact zone and a list of the affected properties of the village of Zograf, municipality of General Toshevo, region Dobrich.

The textual part for elimination of the discrepancies in the territory of the contact zone is presented to the Detailed list of the affected properties (Appendix 11). The cadastral register (Appendix 12) and the list of newly formed properties (Appendix 13) are also attached.

To eliminate the discrepancies, a map of the contact area was made in graphic form, M1: 1000, free layout (Appendix 14).

4.5. Analysis of the impact of the multi-cadastral map on the users of cadastral data

AcCRding to Art. 19 of Ordinance RD 02-20-5 the accuracy in determining the area is:

$$m_{p_{доп.}} = 2\Delta S\sqrt{P}$$

where:

ΔS is a quantity that depends on the accuracy of the coordinates in m;

P - the area of the property in m2.

When the coordinates of the points are determined by geodetic measurements:

The permissible values of ΔS and ∂S for urban areas are:

(a) for points of permanently materialized boundaries of land properties, main buildings and technical infrastructure facilities ΔS <= 30 cm and ∂S <= 20 cm;

b) points of perishable materialized boundaries of land properties and buildings of the additional construction ΔS <= 60 cm and ∂S <= 40 cm.The permissible values of ΔS and ∂S for non-urban areas are:

a) for points of permanently materialized boundaries of land, massive buildings and technical infrastructure facilities ΔS <= 60 cm and ∂S <= 40 cm;

b) for points of non-permanently materialized boundaries of land properties ΔS <= 120 cm and ∂S <= 80 cm;

Permissible values in the area in m²				
Area	Urbanized territory		Non-urbanized territory	
	Permanently materialized	Impermanently materialized	Permanently materialized	Impermanently materialized
100	6	12	12	24
500	13,42	26,83	26,83	53,67
1000	18,97	37,95	37,95	75,84
5000	42,43	84,85	84,85	169,71
10000	60	120	120	240

Their area also plays an important role in shaping the tax and market valuation of land properties. The different accuracy in the urbanized and non-

urbanized territories leads to economic problems in conducting transactions, especially at a high market price per 1 m2.

Conclusions and summaries to Chapter Four

1. The general condition of the developed and subsequently maintained by the structures of the Ministry of Agriculture and Food / MAF / MRP in terms of accuracy is not good due to the fact that the provision of Art. 26 of the PZSPZZ for CRrection of the same. This necessitated the adoption of provisions that would allow the CRrection of errors from the transformed MRP and PZ in CMCR.

2. Obvious factual error is a relatively common phenomenon in the cadastral map. It can be detected with the help of the software product Google Earth and KAIS of AGCC.

3. The state administration should use modern sources and technologies for control of the CC, such as satellite images, aerial photographs, which are ordered and paid for by the Ministry of Agriculture and Food to control payments from the State Fund "Agriculture".

4. Four different cases of incompleteness and errors in the cadastral map, which are located within the boundaries of one settlement, are considered.

5. A case of the contact zone in the territory of the village of Zograf, General Toshevo municipality, district Dobrich.

IV. CONCLUSION

The dissertation analyzes the regulations in the field of cadastre, as well as the sources of errors in the integrated cadastral map.

With the help of SWOT analysis a strategic analysis of the state of the cadastre in Bulgaria was made - the strengths and weaknesses of the integrated cadastral map and the opportunities and threats in the field of cadastre are indicated.

A system of criteria has been proposed, which should be considered open. It can be supplemented with new criteria, as well as excluding some existing ones, depending on the specific objectives.

A methodology for identifying discrepancies in the integrated cadastral map for urbanized and non-urbanized areas has been proposed.

Real experimental researches of different sites in the urbanized and non-urbanized territories have been performed with the proposed methodology for establishing the discrepancies.

For two of the linear objects, the hypothesis for reconciling the empirical distribution with the normal one was performed by Pearson's criterion $\chi 2$ and by calculating the asymmetry, excess and their respective confidence intervals.

From the results obtained and the conclusions drawn, the main conclusion is reached: the maps of the restored property created after 1990 contain many errors, which have been transferred from the existing large-scale topographic maps. ETCs, created in the years 1964-1968, were directly used for the creation of maps of the restored property, without re-aerial photography and deciphering of the sites. Before integrating the cadastral map with the map of the restored property, it is necessary to perform geodetic measurements of permanent topographic objects.

From the research, analysis and the results obtained, it can be concluded that the goals and objectives of the dissertation set in the beginning have been fulfilled.

V. REPORT ON THE CONTRIBUTIONS TO THE DISSERTATION WORK

In the development of the dissertation work have been achieved scientific-applied and applied contributions:

SCIENTIFIC AND APPLIED CONTRIBUTIONS

1. An analysis of the regulations in the field of cadastre and the sources of errors in the integrated cadastral map. Based on the analysis made as the most suitable at this stage to increase the efficiency of the integrated cadastral map, it is proposed to perform geodetic measurements of permanent topographic objects.
2. A methodology for establishing a clear factual error in the integrated cadastral map has been developed.
3. A methodology for identifying incompleteness and errors in the integrated cadastral map has been developed.
4. The hypothesis for reconciling the empirical distribution with the normal one was performed by Pearson's criterion $\chi 2$ and by calculating the asymmetry, excess and their respective confidence intervals.

APPLIED CONTRIBUTIONS

1. Real experimental researches of sites from the territory of Northeastern Bulgaria have been carried out, proving the reliability of the developed methods for the elimination of the discrepancies in the integrated cadastral map and the increase of its efficiency.

VI. LIST OF PUBLICATIONS ON THE TOPIC OF THE DISSERTATION

1. **Niyazi-Yusuf, M.,** "Incompleteness and errors in the cadastral map and cadastral registers - establishment and removal", Journal of Geodesy, Cartography and Land Management, issue 1-2 ‘2020, ISSN 0324-1610
2. **Niyazi-Yusuf, M.,** "Sources of errors in the integrated cadastral map and cadastral registers", Scientific Conference with International Participation MATTEX 2020, Shumen - report, ISSN 1314-3921