The Importance of Creating Topology
in Workflow Systematic Cadastral Records of Romania – CESAR Project

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Abstract: In present is very important that in Romania is implementing a General Cadastre Project, called CESAR, for the systematic registration. Until the start of this project there are made a systematically registration only with local authorities financial funds. In the context of economic crisis is very difficult to cover all the expenditures of such a system. In this paper we want to highlight the actual situation, the main phases of the workflow, the problems encountered and possible identified solutions.

Key-Words: cadastre, systematic registration, CESAR project, ArcGIS, real estate, geospatial data, topology

1 Introduction

Implementing the general cadastre for the whole country is a necessity today. The paper presents the workflow for systematic registration of real estate, highlighting the importance of topology in these works. [2]

The main steps in the errors identifying are the topology creation and other structural applications which are checking the graphical, digital data.

General cadastre system is an unitary and compulsory system for recording of technical, economic and legal attributes of real estate across the country. The main purpose of the general cadastre system is to record real estate in the land register whnich is called Land Book system.

The statistical data provided by ANCPI in the integrated eTerra is including 6200000 registered properties, which represents approximately 15% of the estimated national real estates. In the figures 1 and 2 we can see the main sectors and themes linked with the CESAR Project.

Themes

Rural markets	29%
Rural policies and institutions	29%
Other rural development	14%
Rural services and infrastructure	14%
Land administration and management	14%

Fig. 2 – CESAR Project Themes
(from www.worldbank.com) [10]

Important laws generally applied in the field of cadastre are: Law cadastre and land registration no. 7/1996 and Emergency Ordinance no. 64/2010 on amending and supplementing the Law on cadastre and land registration 7/1996, Land Law no. 18/1991, Decree-Law for the Unification of provisions on Land Book no. 115/27.04.1938, Order no. 534/2001 regarding the approval of the general cadastre technical introduction, Order no. 259/2010 of the Minister of Administration and Interior on amendment of technical standards for the introduction of general cadastre, Order no. 211/2007 of the Minister of Interior and Administrative Reform repealing paragraphs 10 and 13 of the technical rules for the introduction of general cadastre, approved by Ministry of Public Administration no. 534/2001, Order no. 785/2011 of DG NACLR (National Agency of Cadastre and Land Registration) for the amendment of the Regulation on the content and the cadastral

Sectors

General agriculture, fishing and forestry sector	68%
Central government administration	20%
Sub-national government administration	12%

Fig. 1 – CESAR Project Data
(from www.worldbank.com) [10]

documentation for the entry in the land, approved by Order No. DG NACLR 634/2006, Order no. 1184/2011 regarding the approval of DG NACLR Protocol framework of cooperation between NACLR and administrative units to achieve the systematic registration of real estate cadastre and land register, etc..

2 The general cadastre workflow in Romania

General cadastre implementation requires the following flow: measurement and description of real estate, creating cadastral documentation required to register, cadastral representation and storing them on computer media for the recording in the Land Book.

Cadastral map contains the graphical representation of real estate limits of territorial administrative unit, registered in the Land Registry and Cadastral numbers attached to them.

Cadastral documentation is the act of determination the real situation on the ground being prepared by the individuals/legal person authorized in geodesy, topography cadastre having as main obligation to present the real situation the ground.
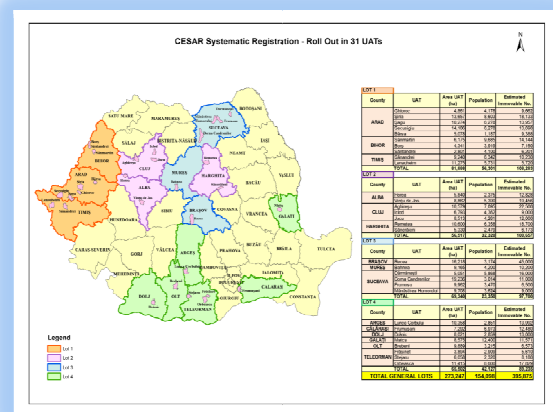
Cadastral documentation underlying land registration in the Land Book are related to:

- Property that require documentation for first registration;
- Property that require documentation for detachment;
- Property that require documentation for union;
- Property that require documentation for submission of final construction on land registered in the Land Book;
- Property that require documentation for modification of the property;
- Property that require documentation for surface modification;
- Property that require documentation to describe dismemberments property right;
- Property that require documentation for reconstitution the land book lost, destroyed or stolen. [1]

CESAR project (Complementing EU Support for Agricultural Restructuring Project), funded by the Government and the International Bank for Reconstruction and Development which is currently developping in Romania represents a very important and significant improvement of the registration system requires an inventory of the real estate and free registration of 91 rural administrative units. The project value is 51.4 million. The objectives of this

technical, economic and legal recording system are to clarify issues about the litigation. In this area of competence the main role is hold by the courts. For the situations to resolve other legal issues related, the competence is belonging to public notaries or land book offices. Another objectives of the recording system are to establish perimeters delineation of special interest, such as those of the reserves, national parks or protected areas, monuments, places of worship, heritage areas, but also to help develop management methods or cadastral data management.

There are several areas in Romania which are performed systematic cadastral works in Figure 3.

Fig. 3 – CESAR Project Map
(according with www.fig.net) [8]

Workflow steps are:
- Collection of primary documents:
  - allotment,
  - parceling maps,
  - cadastral maps,
  - scanned and photocopied documents submitted by holders
- Conduct field measurements (points on the real estate boundaries, points on the infrastructure elements axis points)
  - Urban
  - Outside the city
- Measurement processing and points reporting
- Generating situation maps (with the existing documents: pads, ortho, cadastral maps, etc.).
  - Urban: representing boundaries of the real estate and city blocks
  - Outside the city: boundaries of the real estate
- Organization of primary documents on specific parceling units (city blocks, etc.)
- Urban

G Establishing the link between graphic data and textual data

G Input data in application to generate cgxml file

G Generate of interview pre-filled forms

G Interview on land, checking:

- the documents completeness
- the pre-filled data accuracy
- a correct identification and representation of the buildings limits

G additions and changes resulting from interviews introduction in application

• Outside the city

G The division of land under the assistance of the Hall representative

G Generate the parceling maps and introducing data for each parcel

G Checking and acceptance of parceling maps by Cadastral and Land Registration Office (CLRO)

G Plotting parceling maps and signing to the City Hall

G Generate technical cadastradocuments l to be published

G Preparation and organization of supplied maps

3 WEBCadGen application

National Agency for Cadastre and Land Registration use a desktop application to validate data received from suppliers, both from technically viewpoint (geometry / graphics and textual / descriptive data) and from legal viewpoint (data on ownership and other legal facts). The data validated as correct are loaded on the active layer of real estate in eTerra system. [4], [5]

Fig. 4 The interface of E-Terra software on orthophotomap

NACLR developed an application for managing the real estate in Romaniacalled "e-Terra". [4] (figure 4) This application ensures standardization of spatial data at the national level regarding land and buildings, generating a uniform and coherent database. [6]

The data will be accessible online using Geographic Information System (GIS) technology, through NSDI geoportal (National Spatial Data Infrastructure), component through which Romania contributes to the INSPIRE Directive (Infrastructure for Spatial Information in Europe) of the European Commission.

The main goal NSDI is to ensure public access to spatial data from Romania.

So, the WEBCadGen application is part of a package of tools for transfering data from the general cadastre in the integrated eTerra Cadastre and Land Registry.

The WEBCadGen application (figure 5) was made for cadastral works providers to facilitate their access to existing data in the sporadically cadastre conducted in the area of interest and to enable validation / verification system files resulting from its own production, before submission to the National Agency for Cadastre and Land Registration [9] for delivery within general cadastre project. The provider can retrieve from the eTerra database all relevant information about a administrative unit about a set of selected buildings, etc.. being in order to prepare the general cadastre. It will process using its own production system the extracted data and other data collected in the field, etc.. and will generate a new set of updated data.
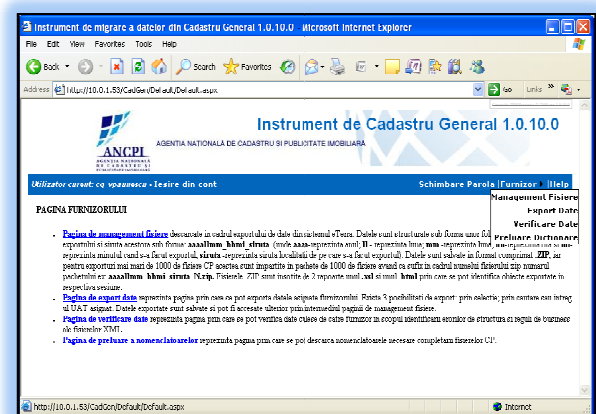

Fig. 5 – Providers page in WEBCadGen application

The product allows the data extraction from the eTerra in electronic cgxml file format, similar to cpxml file format used in sporadically cadastre. Files of cgxml type are similar to files of cpxml type and represent the standard electronic format used for

cadastral information and legal representation - text and graphs - corresponding of a real estate (including parcels, buildings and units that are on them) that are a subject of cadastral and real estate registration NACLR records.

ETerra Information System manages the technical and legal information related to real estate in the CLRO sites and at central NACLR level. The data are stored in compressed zip format.

After verification the application creates a validation report in which will be displayed the cgxml data files, whether they are correct or incorrect, what is the problem and a suggested solution to the problem.

Fig. 6 – Validation report of a cgxml file [6]

Problems that may arise in relation are linked to the graphic structure, for example if the outline of a building is not inside the building, but also linked by textual information, if doesn't exist data about the entitlement.

Fig. 7 – Establishing the topological rules

Other cases are those where the cgxml files received from CLRO hadn't write correctly fractional shares in the registration section, where there were more owners associated with the same real estate. Such errors can be corrected only by CLRO, based on the documents that allowed registrationof ownership.

4 Importance of topology in our workflow

Importance of topology is derived from target objects by defining and enforcing geometric conditions for vector entities. Topology refers to the spatial relationships between graphical entities (points, line segments / circles, polygons).

Thus, creating topology provides us in our case study and carried work the following benefits:

- Ensuring the compliance / consistency of vector graphic informations;
- Creating connections based on alphanumeric relations;
- Supporting analysis functions assumed by the informational computing system;
- Specific approach of contours included in interior, or acceptance of the "islands" on several levels of inclusion;
- It is not permitted to be overlapping / intersection of polygons in the same theme, respectively in the same layer;
- Common boundaries of adjacent polygons of the same theme are usually consisted of a single row of features (it is not recommended sharing the same limits even for polygons of different layers).
- Define a feature point - centroid, within each valid polygon, whose identifier to be unique. This ensures two-way connection with the alphanumerical database and between polygon and records from the database.

In the ESRI Geodatabase structure [12], topology is a collection of rules and relationships that are associated with and supported by a set of techniques and tools for editing. Topological relations are non-metric properties (quality properties) of geographical objects that remain constant when the geographic area of objects is changed or distorted. Topological structuring of the vector thematic layers presents some interesting and useful properties, especially for the polyline (called arc, edge, line and link) and polygon (the surface).

Topological structure of the line and of the thematic layers constrain the ends of lines are within a user-defined distance to be closed in a place so as to have the exact same coordinate values. Wherever ends of line meet or intersect is placed a node. Topology is very important in our cadastral systematic registration because of the role played in the

validation of data, in behaviour imodeling of ntegrated elements, in editing and optimizing queries.

The topology is based on mathematical relationships used to validate geometry of the vector features, of operations such as network connectivity and to verify the adjacency of the polygons.

Checking the topological integrity of the data set is a useful way for validating the quality of geometric data and assessing their applicability for geographical analysis.

We defined phases for geometry control. Topological rules are established only for those classes of features that were populated with vector data.

Topologies allow spatial modeling of classes of features in the database. Rules that must to be respected allow to define the relations between features within the same category of entities (point, line, polygon) and the relationship between elements of different categories. [11]

Topological rules that we have defined for a cadastral sector of the general cadastre work are (In the following description of layers and topological conditions [6] we used the layer names from out informational system - in romanian language - because not all of these names could be translated in english only through a single word. We explained for each layer these names in english between parenthesis.):

• Must Be Larger Than Cluster Tolerance is provided on all groups of polygons, they must overlap taking into account the tolerance required to build topology.

• Must Not Have Gaps is a condition which implies that there are no spaces between certain polygons. In the presented case this condition is imposed between polygons IMOBIL (real estate) and PARCELA (parcel). If there are gaps between polygons described, the software automatically generates another polygon. The software will automatically delete these goals only if they are within the tolerance required to start building topology, and if this rule is not met, the topology will report these validation errors.

• Must Not Overlap is the condition that requiring there is no overlapping polygons together because they have common borders, ie vertices and software may not assign this area to any polygon. This rule will be enforced over the polygons considered: PLANSA (plot), TARLA (a group of properties from outside of city), CVARTAL (a building area limited by streets inside of the city), IMOBIL (real estate), PARCELA (parcel) and CONSTRUCTIE (building) .

• Must Be Covered By defining rules that must be met so that a group of polygons to be fully contained in another polygon, which in its turn may be part of another group, also contained by another polygon. Such polygons IMOBIL are contained by CVARTAL polygon, polygons PARCELA is located in a polygon IMOBIL and polygons CONSTRUCTIE will also be contained in the polygon IMOBIL.

• Must Be Properly Inside determines the position of the text insertion point inside the considered polygon. This rule is useful when texts are references to polygons. Our case means:

- • TEXTPLANSA to be inside the polygon PLANSA
- • TEXTTARLA to be inside the polygon TARLA;
- • TEXTCVARTAL to be inside the polygon CVARTAL;
- • TEXTIMOBIL to be inside the polygon IMOBIL;
- • TEXTNUMARCADASTRAL to be inside the polygon IMOBIL;
- • TEXTPARCELA to be inside the polygon PARCELA;
- • NUMARINTARLA to be inside the polygon PARCEL;
- • TEXTCONSTRUCTIE to be inside the polygon CONSTRUCTIE;
- • DESTINATIECONSTRUCTIE to be inside the polygon CONSTRUCTIE.

• Contains Point is an usually rule [6] imposed to polygons which have associated one text or more texts with different meanings. The position of the associated text insertion point should be inside polygon. Thus, in this case is necessary to:

- • Polygon PLANSA must contain TEXTPLANSA;
- • Polygon TARLA must contain TEXTTARLA;
- • Polygon CVARTAL must contain TEXTCVARTAL;
- • Polygon IMOBIL must contain TEXTIMOBIL;
- • Polygon IMOBIL must contain TEXTNUMARCADASTRAL;
- • Polygon PARCELA must contain TEXTPARCELA;
- • Polygon PARCELA must contain NUMARINTARLA;
- • Polygon CONSTRUCTIE must contain TEXTCONSTRUCTIE;
- • Polygon CONSTRUCTION must contain DESTINATIECONSTRUCTIE.

The next step is to view the topology created and topological features in ArcMap. Thus created topology with its feature classes can be imported as layer.

To facilitate the recognition of topological elements [6] is useful a symbolizing related to their fonts and colors, even of topology errors that are located and identified by the software. (figure 10)
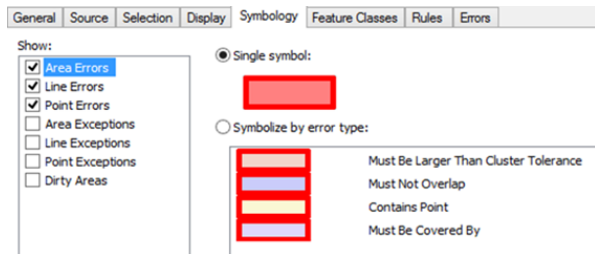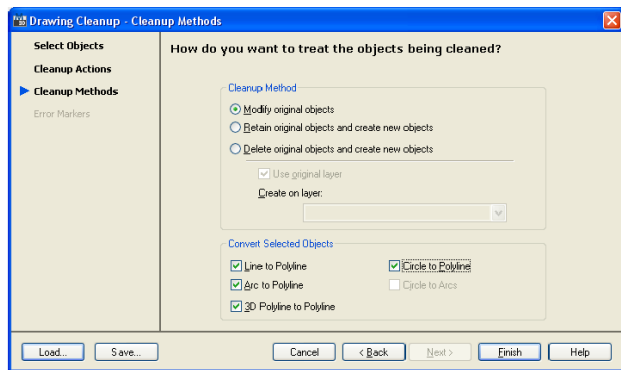

Fig.10 – Symbolizing topological layer

Fig. 11 – Cleaning methods

Fig. 12 – Report on IMOBIL topology [6]

Other types of errors encountered in this work are those of vertices, ie overlapping polygons of the same class or different classes of gaps occurring during the process of correcting topology errors.
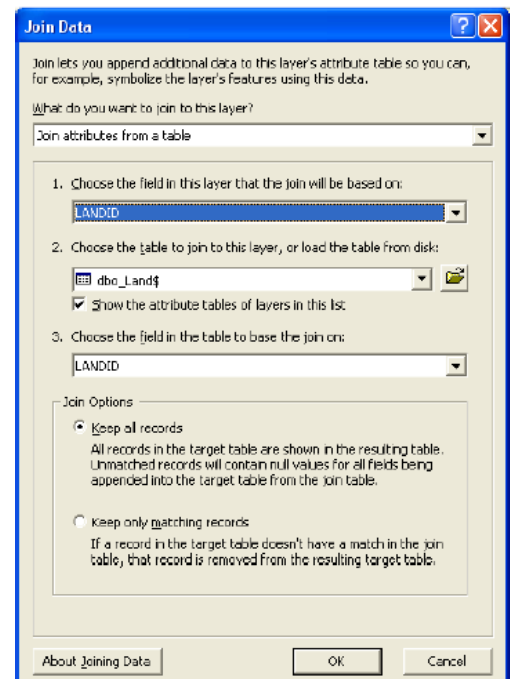

Fig. 13 – Text errors report [6]

Fig. 14 – Linking the MS Excel Table of real estate attributes with the shapefile

It is permitted to edit, input or delete vertices where these interventions are provided, extracting of the small areas created by overlapping polygons (Subtract function) or when there are blank areas between them. [1]

Errors of polygons overlaps or gaps were corrected by moving the vertex or vertices to the right place. (figure 15)
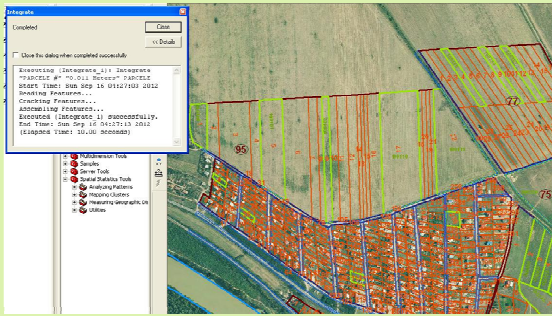

Fig.15 – Rectifying topological errors

After removal of small areas identified as overlaps and gaps errors with Subtract function the vertices have been edited to eliminate errors. These small areas can be also identified by filtering by surface value in the attributes tables.

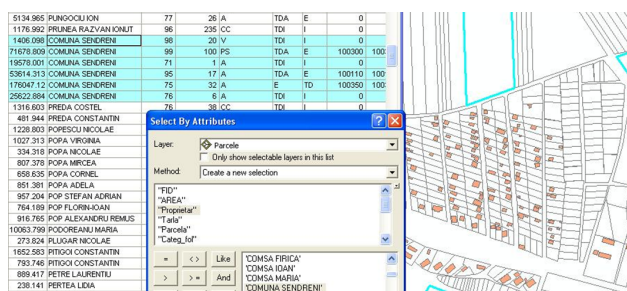Fig.16– Overlapping the parceling maps on the orthophotomap

Fig. 17 – Queries – example

5 Technical and social issues arising during the implementing of systematic cadastral works

• Errors in property titles and into the database obtained from the municipality and CLRO [7]

• After analyzing the data received from the relevant institutions (Hall, CLRO) to identify buildings inheritance, within the site area (outside city limits) arose difficulties only partially expected due to frequent errors existing in the property titles. For example, in many of the title deeds and in database we found misspelled real estate numbers, parcels or neighborhoods.

• Inconsistency of overall cadastral map and the actual situation on the ground

• A very important operation in which Hall plays a significant role is the boundary and cadastral parcels identification by correlating overall cadastral map, scale 1:10,000, with measurements made by the provider. Due to inconsistencies of the overall cadastral map and the actual situation in the field, derived from measurements, there were difficulties in determining the precise boundaries and parcels. In general, to solve this situation is required the presence of a representative of the Village Hall throughout the operation to identify these limits.

• Certificates of Title (and parceling maps) issued by other local governments

• In the vast majority of administrative units are found land for which title deeds have been issued by other local governments (municipalities), sometimes even from other counties. In very few of these cases succeeded - despite persistent approaches - to achieve parceling maps and those property titles. In their absence, the work is considered outstanding and - consequently - is not received.

• Disinterest of the owners and their non-participation

• Although efforts have been made (points of information, posters, flyers, meetings, discussions, etc..) we can conclude (in the deployment phase of the interviews) that a significant percentage of owners /

holders not present at information points to copy and authentication of ownership titles.

6 Conclusions on systematic cadastral registration work

Topological errors are due to operator. It is necessary when are representing the map features of a digital plan to take into account that the attention and responsibility is fully up to operator to make a quality work and the digital plan does not contain many errors;

Systematic national registration brings the following benefits:

- Guaranteeing and ensuring ownership;
- Free registration of property in the real estate recording system;
- Greater social stability;
- Business opportunities and investment growth;
- Citizens can have easier access to mortgage loans;
- Increase mobility and facilitates the transfer of ownership;

• Systematically registration through implementing general cadastre in Romania involves the following benefits:

- Creating a realistic tax base for all buildings;
- Development of mortgages;
- Supporting and ensuring the fulfillment of justice and public administration;
- Reduction of the litigation;
- Developing and monitoring the real estate market;
- Protecting the state property;
- Facilitating land reform;
- Supporting land improvements;
- Improving infrastructure development and urban development;
- Support of environmental protection;
- Eliminating buildings overlapping;
- Provision of statistical data;
- Development of other specific systems which are closely related to systematic cadastral works.

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