

Improvement of the exchange format of the digital cadastral plan

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Abstract: The digital cadastral plan as a collective graphic representation of data on cadastral parcels, buildings, methods of use and addresses is created with CAD tools in DXF exchange format. The content, form and method of creating a digital cadastral plan is defined by regulations and specifications. Maintenance and implementation of changes to the digital cadastral plan takes place in the spatial database of the Joint Information System of Land Registry and Cadastre. To migrate the data of the digital cadastral plan to the spatial database, the shapefile exchange format is used, so it is necessary to convert the digital cadastral plan from DXF to the shapefile exchange format beforehand. In this paper, the compatibility of the data structure of exchange formats and the conditions and limitations in fulfilling the domain consistency and topological consistency for the simplified maintenance of all geometric and attribute relationships on the digital cadastral plan were considered.

Keywords: digital cadastral plan, DXF exchange format, shapefile exchange format

1. Introduction

The cadastral plan of the real estate cadastre is a collective graphic representation of cadastral data that necessarily contains data on the numbers of cadastral parcels, borders and other boundaries of cadastral parcels, boundaries of types of use of parts of cadastral parcels, addresses of cadastral parcels and buildings (position, shape, type of use and house number), Narodne novine, 2008) The Law on State Survey and Real Estate Cadastre (Narodne novine, 2018) defines terms (classes) that are recorded in the graphic part of the cadastral record: " A cadastral plot is part of the area of a cadastral municipality, i.e. a cadastral area at sea determined by the number of the cadastral plot and its boundaries. The boundaries of cadastral parcels are determined by breaking points whose position is determined by coordinates within the prescribed accuracy and are marked on the ground with visible permanent markings. A cadastral municipality is a spatial unit for which a cadastral record is drawn up and, as a rule, it includes the area of one inhabited place with the associated land. For buildings, data on their location, shape, manner of use and house numbers are collected and processed. The address of the cadastral parcel indicates the location of the cadastral parcel by indicating its belonging to a mine, street, square or other geographical name. The method of land use is data on cadastral parcels that is defined for the same types of land use in the economic sense. Special legal regimes are statuses established on cadastral parcels or real estate in accordance with special regulations, which are of cultural, archaeological,

historical, economic and ecological significance and are of interest to the Republic of Croatia and have its special protection.

Denominations and structural lines are data that, in addition to the above, are routinely drawn and entered on the cadastral plan. Names are collective text data about mines, streets, squares, that is, toponyms and other names, while structural lines represent meaningful lines that outline the structure of natural and built objects on the earth's surface.

The need for the abstraction of the real world has existed since the foundation of the cadastral record, which was created on analogue plans with the corresponding book part of the record, i.e. title deeds and lists. Entities shown on maps and plans were drawn with cartographic symbols. Such a documented key or collection of cartographic symbols can be considered as the zero data catalogue of the cadastral plan. The digital cadastral plan of the real estate cadastre is created today in accordance with the *Technical Specifications for creating a digital cadastral plan (DKP) and the graphic part of the digital geodetic study (DGE)* (Official Gazette, 2018). The above technical specifications define the standard exchange file for the digital cadastral plan - AutoCAD 2000 DXF (*Drawing Exchange Format*). The established system for presenting cadastral survey data and the Joint Information System of Land Registers and Cadastres (ZIS) uses the shapefile exchange format Moharić et al. (2018) for the migration of digital cadastral plan data into the spatial database. ZIS is a geoinformation system, i.e. a unique database for cadastre and land registry data, as well as an

application for managing and maintaining cadastral and land registry data (State Geodetic Administration, n.d.) To establish the topological structure of the spatial database, entities of primitive geometric shapes (point, line, surface) in the associated coordinate system are required.

2. Hypothesis

The main hypothesis of this research is that the existing exchange formats, DXF and shapefile, are not fully compatible in terms of the transfer of all attribute data, and that during the conversion of data from one format to another, information is lost, which can affect the accuracy of cadastral data in the ZIS database. and. It is assumed that the shapefile format, although suitable for spatial data, does not allow simplified maintenance of all geometric and attribute relationships that are present in DXF files.

Another hypothesis is that data conversion between these formats can be optimized with the help of improved translation tools and methodologies, which would reduce errors in geometry and object attribution, resulting in increased data reliability in cadastral systems.

A third hypothesis is that future development of standards and specifications for interchange formats, as well as improvements in software tools, will enable better integration of data between different systems and formats and reduce the need for manual correction of errors and inconsistencies in data.

3. Exchange format DXF

Computer programs for technical drawing under the general name Computer-aided design (CAD) have enabled computer two-dimensional and three-dimensional drawing using vector graphics to display geometric shapes. Vector graphics are basically a representation of geometric shapes based on mathematical formulas and equations in an associated coordinate system. Vector formats are by their nature more efficient than raster data formats; therefore, CAD programs have become an indispensable tool of the engineering profession.

In 1982, the software company Autodesk revolutionized computer-aided technical drawing with the product AutoCAD (Autodesk, n.d.-a) In addition to the standard drawing format (DWG) file for saving and exchanging drawings, Autodesk also created the drawing exchange format (DXF), whose original purpose was interoperability between versions of AutoCAD computer programs designed for different platforms. With each new version of the AutoCAD computer program, a new DXF file format was created starting in 1982 (Autodesk, n.d.-b) After the release of the *DXF reference specification* in 1994 (Sustainability of Digital Formats, 2024b). Autodesk made the format interoperability with other computer programs to some extent possible. Consequently, DXF became the de facto standard vector interchange format used for technical drawing.

Data saved in DXF is divided into objects and entities. DXF entities are graphic elements such as line, polyline and text, while objects represent technical and administrative data that are not subject to visualization (such as dictionaries and settings). Drawing elements are organized in layers in AutoCAD, as in most CAD programs. Each layer represents a specific entity or group of geometry that has common properties. Layers are independent parts of a drawing that overlap one another to give a complete view. Drawing takes place in a two-dimensional Cartesian coordinate system that does not have predefined measurement units of the drawing.

3.1 Digital cadastral plan in DXF

Most of today's digital cadastral plans are vectorized data of analog cadastral plans. The first data structure of the digital cadastral plan is described in the Specifications for the vectorization of cadastral plans created with CAD/GIS software (State Geodetic Administration, 2007) With the completion of the translation of the cadastral plan into digital form and its migration to the Joint Information System of Land Registers and Cadastre, a unique database of cadastral data was established, which is based on the legacy cadastral system. An explanation of the data structure of today's digital cadastral plan is available and visible through the technical specifications for the creation of a digital cadastral plan (DKP) and the graphic part of a digital geodetic study (DGE) (State Geodetic Administration, 2018)–hereinafter referred to as Technical Specifications.

Lines forming the boundaries of cadastral parcels, buildings and other structures, cadastral municipality boundaries, methods of use, structural lines, division into detailed sheets of the cadastral plan, measured points, special legal regime and addresses of cadastral parcels are recorded in special layers of the plan. Blocks whose *insertion points* represent the centroids of the number of the cadastral plot, serial number of the building and other buildings and building rights, the way the building and other buildings are used, the house number of the building, the way the land is used and the land on the right of building, are also classified in special layers. number of divisions into detailed sheets of the cadastral plan, breaking points and geodetic base points, special legal regime and address name. There are names in a separate text layer.

Lines on the cadastral plan must be drawn in accordance with the hierarchy from higher order to lower order. The cadastral municipality boundary lines are in the highest hierarchical order, then they are followed by zone boundaries, cadastral plot boundaries, lines of buildings and other structures, and, in the lowest hierarchical order, the use boundary. Drawing double lines with boundary, building and use lines is allowed for layers of underground buildings, boundaries of special legal regimes and address boundaries of cadastral parcels. Boundaries representing structural lines must not be drawn as double lines across other boundaries.

Each specified line must have a start and end point formed by a block in a separate layer. The structure of attribute blocks is also described in the Technical Specifications.

Blocks of centroid numbers of cadastral parcels, centroid of land use, centroid of building use, centroid of serial building number, centroid of house number and centroid of division into detailed sheets are inserted within the superior entity.

The centroid is identical to the insertion point and the required number of text records that are organized as attribute values. The names of buildings and other structures, streets, squares, mines, rivers and other names are written in plain text. An example of a digital cadastral plan in DXF format is shown in Figure 1. Presentation of the digital cadastral plan in DXF A detailed list of the layers of the digital cadastral plan is shown in Table 1. Layers of digital cadastral plan DXF file

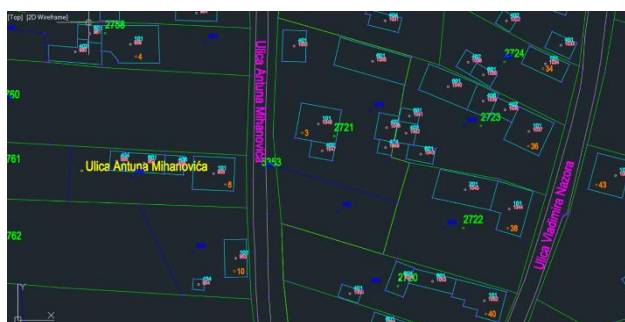


Figure 1. Presentation of the digital cadastral plan in DXF (State Geodetic Administration, 2024)

Layer name:	Description of layer content:	Entity type
0	empty, auxiliary layer	
CADASTRAL PARTICLE:		
1_kc_medja	between cadastral parcels	line
1_kc_medja_spor	disputed borders	line
1_kc_medja_zona	zone border	line
1_kc_medja_ko	border of the cadastral municipality	line
1_kc_number	centroid of the cadastral parcel	block
1_kc_zone_name	zone name	block
BUILDING:		
2_zg	building line	line
2_zg_broj	centroid of the building	block
2_zg_p	the line of the underground building	line
2_zg_p_number	the centroid of the underground building	block

Layer name:	Description of layer content:	Entity type
2_zg_broj_pg	centroid of buildings built on the building right	block
2_zg_p_broj_pg	centroid of the underground building built on the building right	block
2_zg_rb	serial number of the building	block
2_zg_p_rb	serial number of the underground building	block
2_k_number	house number	block
USE:		
3_use	the limit of the mode of use	line
3_use_number	centroid of use	block
3_use_number_pg	centroid of the way of use on the right of construction	block
3_use_area	usage area polygon	line
3_use_area_number	centroid of the area of use	block
STRUCTURAL LINES:		
4_sl_i	i = 00-21	line
NAME:		
5_toponyms_i	i = 01-70	text
7_NETWORK and DL number:		
7_division_i	division into detailed sheets	text and line
7_division_and_number	the centroid of the polygon division into detailed sheets	block
POINTS:		
8_points	points	block
8_points_ogi	points of the geodetic base	block
SPECIAL LEGAL REGIME:		
12_ppr_i	i- a type of special legal regime	line
12_ppr_i_broj	point of insertion of a special legal regime	block
ADDRESSES OF CADASTRAL PARTICLES:		
13_addresses	address polygon	line
13_address_name	the insertion point of the address polygon name	block

Table 1. Layers of digital cadastral plan DXF file (State Geodetic Administration, 2018)

Based on the created cadastral plan in DXF, polygons are closed (polygonization) and attributes are downloaded from the blocks of the superior entity. Geometric errors in the creation of the DXF file of the digital cadastral plan directly affect the errors of translation into shapefile geometry, and the attribution of objects in the DXF directly affects the types of attributes in the shapefile.

4. Shapefile interchange format

Geoinformation systems (GIS) are defined as computer systems for collecting, connecting, analyzing and displaying data and handling and managing data that are spatially referenced to the Earth (Frančula, 2008).

Originally developed for the ArcView GIS geoinformation system in the 1990s (Sustainability of Digital Formats, 2024a), ESRI created a vector spatial data record format called *shapefile*. Shapefile is a non-topological vector format for storing geospatial information consisting of points of lines and surfaces with associated attributes.

For interoperability of the exchange format, in ESRI (1998) published specifications for creating shapefiles, which resulted in availability to a wider range of users.

A shapefile is a record of data consisting of spatial features and their attributes. Shapefile should be seen of three basic files: *main file*, *index file* and *dBASE file*. File names must be identical, respecting the 8.3 naming convention (8 alphanumeric characters and 3 extension characters separated by a period). The suffix of the *main* file is *shp*, the index files are *shx* and the database table is *dbf*. Additional files that can be contained in the directory are listed in (Esri, n.d.), of which the *prj* - coordinate system file is necessary for cartographers. Geometry consists of point, line and surface features. Surface features consist of all coordinates located within a closed polyline (polygons). Attributes are saved in dBASE data format. Each attribute has a one-to-one relationship with the associated geometric shape (ESRI, 1998).

To read a shapefile in a suitable computer program, all components of the file must be in the same directory. The main (*main*) *shp* file stores data about the geometry of spatial data in the Cartesian coordinate system. It consists of a main header and a variable record with associated headers. The main header defines the type of shape (geometry) that will be used in the layer. A point is defined by a pair of coordinates, and a polyline is defined by parts. Polygons consist of one or more chain-connected nodes (parts or rings), and the sequence of these nodes represents the side that makes up the interior of the polygon. Polygon nodes are printed clockwise for the area inside the ring. The coordinates of the last node in the polygon must be equal to the coordinates of the first node to fulfil the condition of a closed ring.

A shapefile index file *shx* consists of headers and records. The layout in the header is identical to the main header of the *shp* file. The record of the *shx* file saves the offset and the length of the record that corresponds to the length of the record in the header of the individual shape in the

main file. The index file provides quick searching, making it easier to access the data in the main file.

The table in which the attributes of individual features are stored is a standard DBF format. The conditions that the attribute table must meet are there must be at least one record for one feature, the order of the records must correspond to the records in the main file, and the date in the header of the dBASE file must be after the year 1900. The records are set in UTF-8 format. Names of columns or attributes in the table are limited to ten characters, and the maximum number of attributes in one shapefile is 255. The attribute table does not have the ability to save empty records (*NULL values*). Since the dBASE file is in a standard format, it is possible to link to other external tables via a foreign key.

4.1 Digital cadastral plan in shapefile exchange format

Digital cadastral plans in shapefile exchange format are the basis for creating a topological data structure by migrating to a database with previously fulfilled spatial conditions. The geometry data of the digital cadastral plan is distributed in layers of point, line or surface form, which must contain files:

- registration number_name of cadastral municipality_layer type.shp,
- registration number_name of cadastral municipality_layer type.shx,
- registration number_name of cadastral municipality_layer type.dbf i
- registration number_name of cadastral municipality_type of layer.prj

The layers of the digital cadastral plan with the described attribute data are shown in Figure 2. Presentation of digital cadastral plan in shapefile exchange format and in Table 2. *List of layers of digital cadastral plan in shapefile***Error! Reference source not found.**



Figure 2. Presentation of digital cadastral plan in shapefile exchange format (State Geodetic Administration, 2024).

Layer name	Layer description	Entity type
2010	breaking points	dot
in 2020	cadastral particles	polygon
in 2021	cadastral parcel number	dot

Layer name	Layer description	Entity type
2030	disputed borders	polyline
2040	addresses	polygon
3010	buildings and other structures	polygon
3030	structural lines	polyline
4010	land use method	polygon
5010	names	dot
5020	house numbers	dot
7010	the border line of the cadastral municipality	polyline
7011	cadastral municipality	polygon
7020	special legal regimes	polygon

Table 2. List of layers of digital cadastral plan in shapefile

The shapefile interchange format has an advantage over the topological structure only in the characteristics of faster manipulation, editing and exchange of data (ESRI, 1998). The topological data structure in GIS represents a set of spatial relations in which the features of the vector data model are represented by primitive topological forms (nodes, edges and surfaces) in accordance with the *Simple Features Access* OGC standard (Open Geospatial Consortium Inc., 2011). In geoinformation systems, topology is implemented through a data structure, in such a way that edges consist of two nodes that have the identifier of the initial and final nodes. Such directed lengths or vectors receive a unique edge identifier. All surface geometry is classified by classes (in layers) with a unique identifier. Given that surfaces consist of all points on the right or left side of the vector, edges are joined by unique identifiers of the surfaces located to the right and left of the edge. The creation of a topological data structure results in the reduction of excessive data, because the edges that make up the edges of the surfaces are saved only once. This is exactly not the case with shapefile polygons, which store their edges (polylines) twice. Due to such a record, there may be overlapping, divergence and creation of cracks between the polygons, which disrupts the consistency and continuity of the data display on the plan. The shapefile of the digital cadastral plan is imported into the spatial database; therefore it is necessary to define domain attribute conditions, topological conditions and restrictions on the data.

5. DXF to shapefile conversion

The conversion of a DXF file of a digital cadastral plan into a shapefile is related to the types of geometries and the type of attribute data. To create a specific layer of geometry (shape) data from a DXF file, it is necessary to determine which geometry is downloaded and which data from the blocks will fill the attribute table in the dbf file.

Line, text and block data of DXF layers of the cadastral plan, by translating into shapefile format, become entities of primitive geometric shapes (point, line, surface) in the associated coordinate system, which are necessary for

migration to the spatial base of the topological data structure.

Point shapefile layers are formed from block and text DXF layers. Polygonal layers are formed from line objects of the DXF file of the cadastral plan. The centroids recorded in DXF are the key data for the polygonization of objects and filling the attribute table of the dbf file. The absence of centroids or attributes of DXF blocks directly affects the impossibility of creating shapes and attributes in the shapefile. DXF blocks such as breakpoints, cadastral parcel numbers, house numbers and text layer names are translated into point entities of shapefile layers. DXF blocks consisting of cadastral plot numbers, serial numbers of all buildings, underground buildings and buildings with the right to build, initial use of buildings, land use and land use with the right to build, blocks of a special legal regime and the text layer of address names participate only in downloading attributes and geometric polygonization of objects, and special shapefile layers are not created from them. The line objects of the DXF file, which are disputed boundaries, structural lines distributed in several layers and cadastral municipality boundary lines, are directly translated into shapefile line shapes. DXF file data must not contain layer errors, block errors, and geometry errors. Polygonization processes for each shapefile layer in which layers are selected must be separate and independent.

The quality element of all features on the cadastral plan, originally created in DXF and translated into the shapefile under review, is the logical consistency control. Domain consistency and topological consistency are identified. Domain consistency refers to the conformity of attribute values with the codebooks defined by the Technical Specifications. Topological consistency is a control that determines that features are defined by a topological structure in a continuous Euclidean two-dimensional space.

The topological conditions and restrictions are that the polygons of the union of all cadastral parcels must overlap the polygon or polygons of the border of the cadastral municipality. Single or double points are not allowed. Polygons of adjacent cadastral particles must touch and must not overlap or diverge. Each feature on the building and other structure layer must be contained within the polygonal geometry of the cadastral particles. The geometry of the use layer must touch features within the same layer or with features within the building and other structure layer. The polygon of the superior cadastral parcel must contain the union of feature polygons on the layers of the building and other buildings and ways of use. Polygons of addresses must correspond to the union of polygons of cadastral particles. House numbers must be contained within buildings. The existence of double polygons and double lines in the layer of cadastral particles, buildings and other structures, methods of use, disputed borders and structural lines is not allowed. The border of the cadastral municipality

must correspond to the nodes of the outer ring of the polygon of the cadastral municipality. space.

The most rigid control of attribute data is related to the unique number of cadastral parcels in the cadastral municipality. All attributes in the dbf file must be filled in and in accordance with the code books. Sequence numbers of all features must be unique within a layer and numbered from 1 to n. House numbers with the same neighbourhood and street code attributes must be unique.

The compliance of the data with the specified conditions and restrictions provides an assessment of the suitability of the migration of the shapefile exchange format of the digital cadastral plan to the spatial database in ZIS.

6. Discussion

If we consider the key challenges and problems in the implementation of DXF and shapefile formats in practice, the DXF format is widely accepted in the industry due to its flexibility and the possibility of precise technical drawing, but its use in the context of cadastre brings certain technical challenges. The first difficulty is the compatibility between the different versions of the DXF format that have been developed over the years, which can lead to data incompatibilities during exchange. The Shapefile format, on the other hand, offers advantages in ease of manipulation and fast data processing, but lacks the topological structure that is essential for cadastral data. Topological errors that occur when converting data from DXF to shapefile format can cause inaccuracies in the geometry of cadastral parcels and other objects, which can lead to legal uncertainties regarding property ownership and boundaries.

Further discussion focuses on challenges in managing data layers in DXF and shapefile. DXF format allows detailed control over layers and objects within the drawing, but when translating to shapefile format, the interpretation of layers is extremely important, so as not to cause loss of attribute data. Although a shapefile allows for quick data manipulation and transfer, additional validation is often required to ensure the correctness of the data after conversion.

Suggestions for improving the data conversion process, including the use of more advanced polygonization algorithms and automated error detection tools, are also discussed. The potential for further development of exchange formats that would enable simpler and more reliable data exchange between different cadastral systems is also being considered.

Hypothesis 1: The existing exchange formats, DXF and shapefile, are not fully compatible in terms of transferring all attribute data, and information is lost during conversion.

Confirmation: The first hypothesis was confirmed through the analysis of specific problems that occur when converting data between DXF and shapefile formats. Research has shown that during the translation from DXF to shapefile format, there is a loss of layers and entities that are maintained on cadastral plans (points of the geodetic base, grid and division into detailed sheets). In

the shapefile format, some attribute data from the DXF format are not downloaded, especially the attribute information about the ordinal numbers of the names, structure lines and usage methods. Geometrical errors in DXF files often manifest in shapefile formats as inconsistencies in the shaping of polygons and lines, which confirms the claim that compatibility between these formats is not complete.

The research identified specific errors, such as problems with polygonization in the shapefile, where there is overlap and divergence between objects, which further confirms this hypothesis.

Hypothesis 2: Data conversion between DXF and shapefile formats can be optimized with the help of advanced tools and methodologies, which would reduce errors in geometry and attribution of objects.

Confirmation: The second hypothesis was also confirmed by research involving the use of different software tools for data conversion and analysis of their results. The use of advanced software solutions that include algorithms for automatic error detection during conversion has shown a significant reduction in errors in geometry and attributes. Research has shown that modern polygonization and layer verification tools can automatically detect defects such as inconsistencies in cadastral parcel boundaries and structural lines and correct them.

Application of new methods enabled more precise control and reduction of geometric errors when transferring data from DXF to shapefile format, which confirmed that process optimization can reduce errors and improve overall data quality.

Hypothesis 3: Future development of standards and specifications for interchange formats and improvements in software tools will enable better data integration and reduce the need for manual error correction.

Confirmation: The third hypothesis was confirmed through a detailed analysis of existing standards and proposals for future improvement. The research indicated that the development of new specifications for interchange formats, which would include broader capabilities for automatic data verification and integration, could significantly reduce the need for manual error correction. Some of the proposed standards include more control over topological structure in shapefile formats, as well as better support for complex geometric entities in DXF format.

In addition, further development of software tools would enable automatic identification and correction of errors during data conversion, which would reduce the need for manual interventions. This would achieve greater reliability of data in cadastral systems, which confirms that the improvement of standards and tools is the key to better integration and automation of processes in the future.

Based on these results, the research showed that in the long term it is possible to reduce manual corrections and

improve the efficiency of data exchange through the improvement of standards and tools.

7. Conclusion

In conclusion, the research showed that DXF and shapefile formats represent key tools in the exchange and migration of cadastral data, but there are significant challenges in their mutual interoperability. The DXF format offers precision and detailed control over layers and objects, while the shapefile format offers speed and simplicity in data processing, but with certain compromises in terms of topological structure.

The main obstacle in the process of data conversion from DXF to shapefile format lies in the loss or incompleteness of attribute data and the appearance of topological errors. Therefore, it is necessary to develop more sophisticated methods and tools for translating data between these formats to minimize errors and ensure data consistency.

Further research should focus on improving standards for the exchange of spatial data and developing tools that will enable automatic detection and correction of errors during data conversion and migration to a spatial database. This would increase the reliability and efficiency of cadastral systems, which would have a positive effect on legal certainty and the availability of data to users.

8. References

- Autodesk. (n.d.-a). *A brief history of AU*. Retrieved October 29, 2024, from <https://www.autodesk.com/autodesk-university/blog/brief-history-AU-2015>
- Autodesk. (n.d.-b). *Drawing format version codes for AutoCAD*. Retrieved October 29, 2024, from <https://www.autodesk.com/support/technical/article/caas/sfdcarticles/sfdcarticles/drawing-version-codes-for-autocad.html>
- Esri. (n.d.). *Shapefile file extensions*. Retrieved October 29, 2024, from <https://desktop.arcgis.com/en/arcmap/latest/manage-data/shapefiles/shapefile-file-extensions.htm>
- ESRI. (1998). *Environmental Systems Research Institute . Shapefile Technical Description*. <https://www.esri.com/content/dam/esrisites/sitecore - archive/Files/Pdfs/library/whitepapers/pdfs/shapefile.pdf>
- Frančula, Nedjeljko. and L. M. (2008). *Geodetsko-geoinformatički rječnik*. State Geodetic Administration, Zagreb.
- Moharić, J., Vorel Jurčević, B., & Antonio, Š. (2018). Quality of digital cadastral data. *Proceedings of the 11th Symposium of Certified Geodetic Engineers, Paar, R. (Ed.)*, 145–151.
- Open Geospatial Consortium Inc. (2011). *OpenGIS® Implementation Standard for Geographic information - Simple feature access - Part 1: Common architecture*. <http://www.opengis.net/doc/is/sfa/1.2.1>
- State Geodetic Administration. (n.d.). *Zajednički informacijski sustav zemljišnih knjiga i katastra*. Retrieved October 29, 2024, from <https://dgu.gov.hr/zajednicki-informacijski-sustav-zemljisnih-knjiga-i-katastra/161>
- State Geodetic Administration. (2007). *Specifications for vectorization of cadastral plans created with CAD/GIS software*. State Geodetic Administration, Zagreb.
- State Geodetic Administration. (2018). *Technical specifications for the creation of a digital cadastral plan (DKP) and the graphic part of a digital geodetic study (DGE)*. State Geodetic Administration, Zagreb.
- State Geodetic Administration. (2024). *Sveti_Ilija.dxf*. State Geodetic Administration, Zagreb.
- Sustainability of Digital Formats. (2024a). *Library of Congress Collections*. <https://www.loc.gov/preservation/digital/formats/fdd/fdd000280.shtml>
- Sustainability of Digital Formats. (2024b). *Sustainability of Digital Formats: Planning for Library of Congress Collections*. <https://www.loc.gov/preservation/digital/formats/fdd/fdd000446.shtml>