# VREDNOTENJE KMETIJSKIH ZEMLJIŠČ PRI KOMASACIJAH V OKOLJU GIS

# LAND CONSOLIDATION APPRAISAL OF AGRICULTURAL LAND IN THE GIS ENVIRONMENT

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## IZVLEČEK

*Kmetijska zemljišča so pomemben vir za družbo, kjer se prepletajo različni interesi. Varovanje kmetijskih zemljišč in njihovo izboljšavo, različne funkcije teh zemljišč, prostorski obseg kot tudi parcelno strukturo urejajo različni zakoni. Neugodno parcelno strukturo zemljišč pogosto obravnavamo kot oviro smotrnemu in trajnostnemu upravljanju kmetijskih zemljišč. Pomemben pristop k reševanju te ovire je zagotovo preureditev zemljišč z instrumentom komasacije zemljišč. Postopek preoblikovanja strukture kmetijskih zemljišč s komasacijo vključuje vrednotenje kmetijskih zemljišč, ki je eden izmed najbolj občutljivih in zahtevnih delov komasacije. V članku predstavljamo standardno metodologijo vrednotenja kmetijskih zemljišč, ki se je uveljavila v postopkih komasacije kmetijskih zemljišč v Srbiji. Dodatno podajamo pregled možnosti vključevanja različnih prostorskih podatkovnih virov ter uporabe analiz prostorskih podatkov za namene vrednotenja kmetijskih zemljišč pri komasacijah.*

## ABSTRACT

*Agricultural land is an important resource for the society, where many interest for land use meet. Preservation of the agricultural land and its improvement, different functions, spatial exposition as well as land plot structure are regulated by different laws. Unfavourable land plot structure is often considered as a problem for suitable management of agricultural land. An important approach to solving this problem is the land rearrangement tool called land consolidation. Agricultural land rearrangement within the land consolidation procedure includes agricultural land appraisal, which is the most delicate and the most demanding part of land consolidation works. The present paper provides an overview of a standard land appraisal methodology implemented in the land consolidation procedure in Serbia, with an additional overview of the possibility to use different geo-data sources and spatial data analyses for valuating agricultural land during the land consolidation process.*

## KLJUČNE BESEDE

komasacija, kmetijska zemljišča, prostorske analize, GIS, Srbija

## KEY WORDS

land consolidation, agricultural land, spatial analyses, GIS, Serbia

## 1 INTRODUCTION

The process of consolidating fragmented agricultural land, as an agricultural reform measure has been used in many countries around the world, and is not new in Serbia. The first legislation mentioning land consolidation in Serbia dates back to the 14th century. The first land consolidation efforts in the territory of Srem (Northwestern part of Serbia) were done pursuant to the Law on Land Consolidation passed in 1891, in force until 1941. In the 1980s, the Law on Agricultural Land Use was passed which included also the topics from the field of land consolidation (*Official Gazette of SRS, 52/1989*). Presently, land consolidation in Serbia is conducted according to the Law on Agricultural Land (*Official Gazette of RS, No. 41/2009*).

The earliest land consolidation attempts in the world were made in Scandinavia, in particular in Finland, Sweden and Denmark, where major land consolidation projects were implemented already in the 18th and 19th centuries. Three major land reforms involving land consolidation were implemented in Sweden from 1750 to 1920, which included successful land consolidation schemes (Osterberg and Pettersson, 1992). The first law on land consolidation in Finland was passed in 1757 (King and Burton, 1982), while the first law on land consolidation in Denmark was passed in 1781 (Binns, 1950).

In Eastern European countries, agricultural reforms were performed mainly after 1918, which may be historically seen as the consequence of war, liberation or conquering of territories and changes of the societal system. In particular after the Second World War, the agricultural reform brought socially owned properties, common interest goods, in the form of agricultural funds (cooperatives), while assigning small size properties to the citizens not owning agricultural properties. Such processes resulted in repeated fragmentation of agricultural land, changes in holding (ownership), different distribution of agricultural land, as well as different division of agricultural properties as per size (Thomas, 2006). An important milestone was the transition period in the 1990s, i.e. for the Central and Eastern European countries in the transition from planning to market economy. Here, the land consolidation process was implemented as part of a comprehensive strategy to depart from planned agricultural production, specific for socialistic societies, towards the privatization and market-oriented economy aimed at increasing agricultural revenues. The land consolidation procedure, as a measure of land reform in transitional countries, covered also the countries of Latin America, Asia and of South Africa, aiming at reduction of territory fragmentation (Mackenzie, 1993).



The majority of European Union (EU) Member States are still involved in the agricultural land rearrangement processes through land consolidation procedures. In the past years, the majority of the old Member States performed agricultural land consolidations predominantly aiming at preservation of the environment and cultural heritage, along with infrastructural facilities development. The EU Member States do not have a unified legislation regulating land consolidation. Each state regulates the field of land consolidation by its own legislation and by-laws; however, as a general precondition, land consolidation requires a suitable political and social climate and the awareness of political opinion leaders about the crucial role that land consolidation plays for rural development, land market development, and land administration quality in general.

State responsibility for land consolidation at the national level is to be recognized, along with the political will to use land consolidation as a suitable tool for agricultural land management and to create the

appropriate legislation and administrative infrastructure. Land consolidation should be an essential part of on-going national development programs in cases where land consolidation is missing in the accession programs of European Union candidate countries (Thomas, 2002).

### 1.1 Land valuation for the purpose of land consolidation

The aim of land valuation is to obtain values on land entered in the consolidation procedure, per particular criteria. Land valuation is a process of predicting the productive ability of land, containing the procedures to be applied when comparing various land types and characteristics (FAO, 1976; Gundogdu et al., 2003; Lisec, 2007; Hendricks and Lisec, 2014). Development of GIS technology has brought several challenges in the fields of land consolidation, including land valuation. Land valuation for land consolidation in Finland is performed in the GIS environment, based on cadastral data integrated into digital data on land parcel values within the cadastral borders, digital topographic databases, soil quality data, market data, and with timber volume in forest areas (Uimonen, 2002).

Agricultural land valuation for land consolidation in Serbia is performed pursuant to Article 35 of the Law on Agricultural Land (2009), in line with The Instructions on Geodetic-Technical Works and Determination of Land Value in the Land Consolidation Process (*Official Gazette of SRS, No. 3/1977*), and the Rulebook on Cadastral Classification and Land Fertility Valuation (*Official Gazette of RS, No. 63/2014*). One of the fundamental principles of land consolidation is that each participant has to get a rounded property with an equal area, and the same or very similar soil quality as the given land. In order to adhere to the fundamental land consolidation principle, *land valuation for land consolidation* is performed as a rule, being the key and the most demanding operation of the entire land consolidation procedure.



## 2 LAND VALUATION METHODS FOR LAND CONSOLIDATION IN SERBIA

### 2.1 Legal basis of land consolidation in Serbia

Pursuant to Article 31 of the Law on Agricultural Land (2009), land consolidation in Serbia is carried out in the following cases:

- when great fragmentation and irregular shape of cadastral parcels prevent rational use of agricultural land;
- when a drainage or irrigation system is being built;
- when field roads' network is being built;
- when development of infrastructural facilities (public roads, railroads, accumulations) and expansion of the construction region imposes fragmentation of the existing cadastral parcels;
- when counter-erosion works and measures need to be implemented.

Land consolidation in Serbia is performed by the *Land Consolidation Commission*, established by the local administrative unit. The Commission forms a sub-commission for land valuation in the framework of land consolidation and a sub-commission for valuation of growing crops. The land valuation sub-commission is responsible for soil classification works and fertility valuation, and a minimum of two representatives of land owners participating in the land consolidation (*Article 35 of the Law on agricultural land, 2009*). Pursuant to Articles 13 and 14 of The instructions on Geodetic-Technical works and Determination of

Land Value in the Land Consolidation Process (1977), the land valuation entails an *approximate land valuation* that determines the number of valuation grades (classes), their relations and a *detailed land valuation* that classifies individual lands in the established valuation grades. Classification of all lands in the valuation grades is performed pursuant to:

- soil fertility,
- climate conditions, and
- economic factors;

entered in the "Records on approximate land valuation", to be publically available and adopted by the owners participating in land consolidation (*Article 20 of The Instructions on Geodetic-Technical works and Determination of Land Value in the Land Consolidation Process, 1977*).

During the land valuation process, land is classified for the entire land consolidation area into a maximum of eight valuation grades, taking into account land characteristics, and presented for the individual units of natural soil classification. Quantitative valuation of soil production capacities sorted into grades is expressed by average yields of prevalent agricultural crops in the land consolidation area (maize, wheat, barley, sugar beet, sunflower, alfalfa, etc.) and the land market value. The average yields of the first valuation grade are taken as a comparison factor with coefficient 1.00, while the yields of other valuation grades are relatively compared to those with the first valuation grade.



Market land value is determined in a similar manner, according to the defined valuation grades. Based on the value obtained from yields and market value, the coefficient is calculated per valuation grades (*Article 17 of The Instructions on Geodetic-Technical works and Determination of Land Value in the Land Consolidation Process, 1977*). Boundaries of valuation grades are surveyed in the field, and mapped over the original cadastral maps (*Article 22 of The Instructions on Geodetic-Technical works and Determination of Land Value in the Land Consolidation Process, 1977*).

### 2.2 Overview of land valuation for the land consolidation analysis in the study area

The selection of the study area for this study aiming to improve the land valuation process in the framework of land consolidation in Serbia has been performed depending on the available data, which may be relevant for the valuation. The cadastral municipality of Feketic (CM Feketic) in the political municipality of Mali Idjos, the county of Severna Bačka, was selected as the study area (6065 ha), situated in the Pannonian Plain (Figure 1). Land valuation for land consolidation was performed in July 2013, for the total area of 6065 hectares.

The classification of land into the valuation grades was based on soil fertility parameters, i.e. pedology-morphology, physico-chemical properties of soil, and climate and economic elements. Aiming at the highest possible accuracy of soil fertility and soil types' determination, the sub-commission evaluated 333 soil profiles. Based on the field survey and the results of soil laboratory analyses, the following soil types were determined:

- Chernozem;
- Alluvium (fluvisol);
- Fluvial meadow soil (humo-fluvisol);
- Colluvial soil (coluvium);

— Rendzina;
— Marsh humus (humoglej);
— Rigged soil (rigosol).

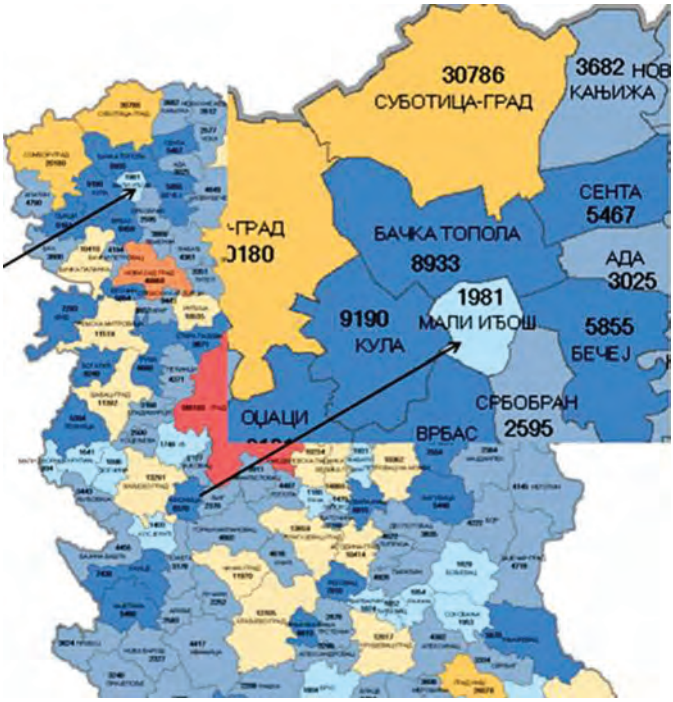


Figure 1: Geographic position of CM Feketic, the Municipality of Mali Idjos (Source: RGZ, 2014).

Table 1: Scale of relations between valuation grade values, yields and market land values.

| Valuation grade | Coefficient | No. of units per 1 ha | Average yields kg/ha Coefficient | | | | | Market value EUR/ha |
|---|---|---|---|---|---|---|---|---|
| | | | Maize | Wheat | Soy | Sunflower | Alfalfa | |
| 1 | 1.00 | 10000 | 7500<br>1.00 | 6000<br>1.00 | 3250<br>1.00 | 3500<br>1.00 | 10.000<br>1.00 | 9000<br>1.00 |
| 2 | 0.95 | 9500 | 7125<br>0.95 | 5700<br>0.95 | 3120<br>0.96 | 3290<br>0.94 | 9500<br>0.95 | 8550<br>0.95 |
| 3 | 0.86 | 8600 | 6450<br>0.86 | 5220<br>0.87 | 2760<br>0.85 | 3045<br>0.87 | 8500<br>0.85 | 7740<br>0.86 |
| 4 | 0.74 | 7400 | 5475<br>0.73 | 4500<br>0.75 | 2370<br>0.73 | 2625<br>0.75 | 7400<br>0.74 | 6660<br>0.74 |
| 5 | 0.55 | 5500 | / | / | 1790<br>0.55 | / | 5500<br>0.55 | 4950<br>0.55 |
| 6 | 0.20 | 2000 | / | / | / | / | / | 1800<br>0.20 |
| N/A | / | / | / | / | / | / | / | / |

The ratios between the valuation grades were determined based on the survey, the statistical municipal data of agricultural crop yield, and the land trade value data obtained from the Tax Administration. The scale of relations between valuation grade values, yields and market land values is obtained by processing statistical data within each valuation grade and for each culture and market land value (by adjusting to the mean values) and by data processing, through comparing to the first valuation grade (Table 1).

The scale of relations between valuation grades in the land consolidation area is shown in Table 2.

Table 2: Scale of ratio between appraisal grades.

| Valuation grade | 1st VG | 2nd VG | 3rd VG | 4th VG | 5th VG | 6th VG |
|---|---|---|---|---|---|---|
| | 1.0000 | 0.9500 | 0.8600 | 0.7400 | 0.5500 | 0.2000 |
| 1st VG | **1.0000** | 1.0526 | 1.1628 | 1.3513 | 1.8182 | 5.0000 |
| 2nd VG | 0.9500 | **1.0000** | 1.1046 | 1.2838 | 1.7273 | 4.7500 |
| 3rd VG | 0.8600 | 0.9053 | **1.0000** | 1.1622 | 1.5636 | 4.3000 |
| 4th VG | 0.7400 | 0.7789 | 0.8605 | **1.0000** | 1.3454 | 3.7000 |
| 5th VG | 0.5500 | 0.5789 | 0.6395 | 0.7432 | **1.0000** | 2.7500 |
| 6th VG | 0.2000 | 0.2105 | 0.2326 | 0.2703 | 0.3636 | 1.0000 |



Table 2 shows that 1 ha of land in the 1st appraisal grade is equal to 1.0526 ha in the 2nd appraisal grade, with the value of 1 ha being 10,000 value units. The total value of land in the land consolidation area can be calculated as follows:

$$V_i = \sum_{j=1}^{n} w_i \times P_{ij} \tag{1}$$

where

$V_i$ is the value of agricultural land of $i$ appraisal grade,

$w_i$ is the weight of the appraisal grades, and

$P_{ij}$ is the polygon area of $I$ appraisal grade.

Graphical overview of valuation grades in the land consolidation area in the CM Feketic is shown on Figure 2.

The basic distribution rules of the land consolidation bulk pursuant to Article 42 of the Law on Agricultural Land (2009) are that the total value of land assigned from the land consolidation bulk shall not vary by more than 10% against the total value of the land included in the land consolidation bulk (common purposes land included), so that the total area of the land assigned from the land consolidation bulk shall not vary by more than 20% against the total area of the land included in the land consolidation bulk, except if the Commission and the owner participating agree otherwise. Appeals against distribution of the land consolidation bulk are submitted to the ministry competent for agriculture (*Article 44 of the Law on Agricultural Land, 2009).*

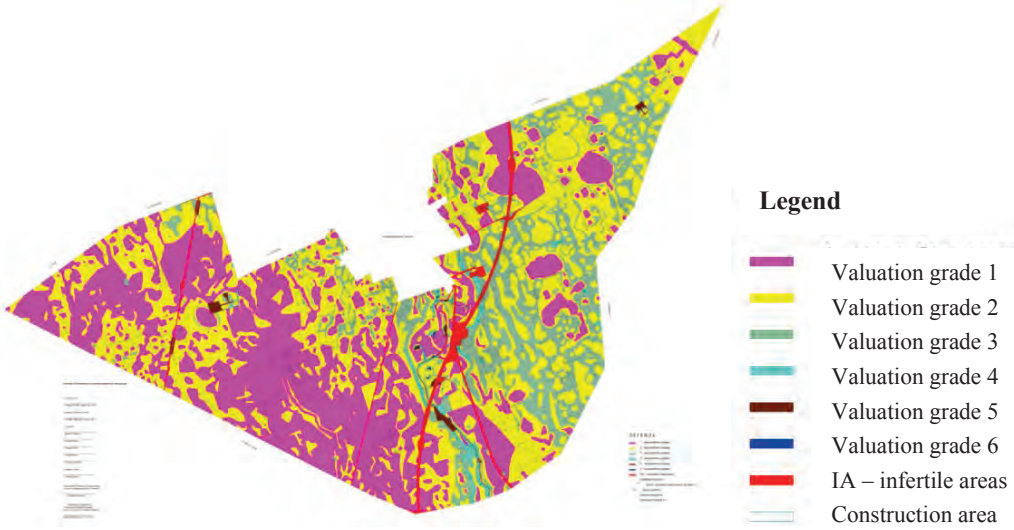


Figure 2: Map of valuation grades in the land consolidation area in Feketic.



## 3 LAND CONSOLIDATION IN THE GIS ENVIRONMENT

### 3.1 Geospatial data

The basic infrastructural base for geodetic-technical works and land valuation for land consolidation purposes in Serbia is established by the *Real Estate Cadastre*. The *Real Estate Cadastre* is a unique, public register of properties containing data on land (cadastral parcels of agricultural, forest, urban and other land), underground and above ground constructions, special parts of construction constituting a construction unit (apartment, shop/office, garage and other) and on property rights. The Republic Geodetic Authority (RGZ – *Republički geodetski zavod*), in line with the European initiatives and trends, adhering to the *INSPIRE*[1] Directive principles, is successfully implementing activities within the *National Spatial Data Infrastructure* established in Serbia, being an integrated system of geospatial data, enabling the users to identify and access spatial information collected from various sources – from local and national to the global level, in a comprehensive manner. Here, geospatial data are defined as data directly or indirectly linked to a particular location or geographic area. Spatial data refer to separate themes, systemized per groups or themes, collected by governmental authorities per *levels of governments and pursuant* to adopted spatial thematic data (Aleksić, Gučević and Miličević Sekulić, 2014).

Cadastral data containing also property records on agricultural parcels, integrated with geodata from various sources, provide the possibility for use and analysis of spatial data, which are important for agricultural land valuation within the land consolidation procedure. Application of GIS technology provides quality professional description and quantifies the key factors influencing land valuation; it contributes to improvement of the valuation method itself, the data acquisition procedure concerning the attributes relevant for valuation, analysis of results, and the drawing of conclusions.

[1] *Directive 2007/2/EC of the European Parliament and of the Council, dated 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).*

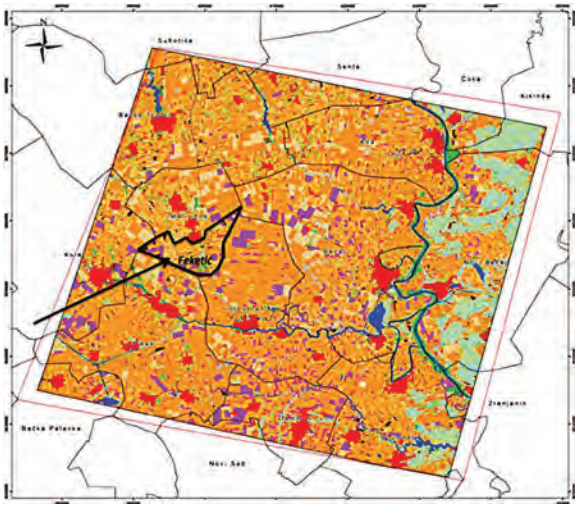


Figure 3: Map of agricultural crops (Source: RGB, 2015)[2].



Data acquisition by means of remote sensing, including new and different data categories, is not contradicting or exclusive towards the classical measurement methods; instead they are complementary, making them more objective and reliable (Manić, 2006). The remote sensing data can serve as the basis for the analysis and synthesis of certain spatial data, and are appropriate for much wider spatial areas when compared to field research (Figure 3).

Here, it has to be mentioned that in 1998, the National Land Survey Agency in Finland introduced the new official spatial data infrastructure based on GIS, and based on cadastral information (JAKO cadastre), with integrated data on cadastral parcels' attributes and spatial data in a single database. Integrated cadastral and spatial data on properties, survey, land consolidation, property rights registration, and property valuation for taxation purposes resulted in integrated data within the cadastral system (Vitikainen, 2003).

Digital cartographic and cadastral data are gaining in importance, as they are a very important GIS component, thus a great attention is paid to the geographic data quality control thus the reliability degree influences the results of geographic information analyses.

### 3.2 Proposal of a land consolidation valuation methodology in the GIS environment

Integrating textual and graphical data on land, within land consolidation valuation, into the geo-information systems means to create a spatial database which covers the entire valuation territory, without limitations regarding spatial information presentation and textual data regarding land. Within the framework of the research performed on agricultural land valuation for the land consolidation in the GIS environment, a research methodology was applied based on defining goals and assumptions on the possibilities to improve the land valuation procedure in Serbia.

The proposed methodology procedure to improve land consolidation valuation using GIS technology provides flexibility, and allows for iterative modification in the course of the study for the purpose of

[2] *IGIS (Integrated Geo-Information Solution for NSDI and Remote Sensing Center)*

improving agricultural land valuation for land consolidation. Schematic presentation of the land consolidation valuation methodology in the GIS environment proposal is shown in Figure 4.

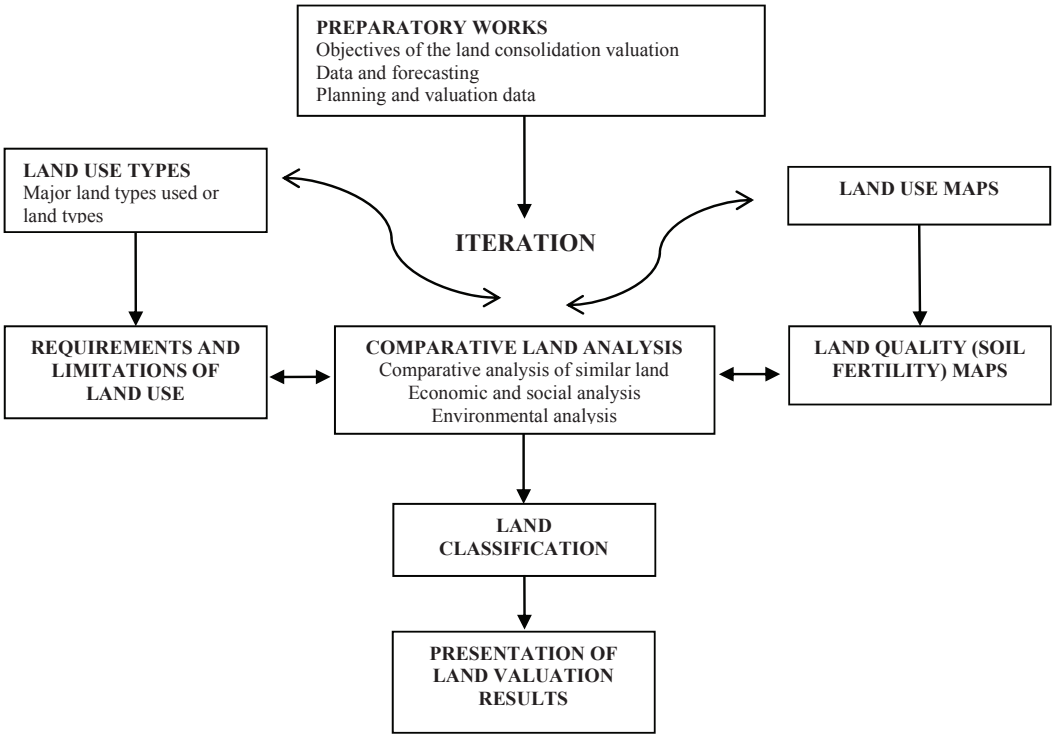


Figure 4: Schematic presentation of the land consolidation valuation methodology in the GIS environment.

## 4 GIS ANALYSIS

### 4.1 Spatial analysis

Relevant spatial analyses were performed pursuant to the defined proposal of land valuation for the land consolidation methodology in the GIS environment. The research was performed using available digital data sources, i.e. graphical and textual databases:

- Pedology map, scale 1:50,000, raster format;
- Orthophoto of CM Feketic, acquisition epoch 2009, scale 1:3000;
- Digital cadastral map of CM Feketic, scale 1:2500;
- *Real Estate Cadastre* database for CM Feketic.

The pedology map in raster format, scale of 1:50,000, for the land consolidation area of the cadastral municipality of Feketic, municipality of Mali Idjos, contains the presentation of three soil types (Figure 5):

- Chernozem, carbonate, on the loess plateau (15);
- Chernozem, carbonate, on the loess terrace (16);
- Chernozem, with signs of swamping on the loess (20).

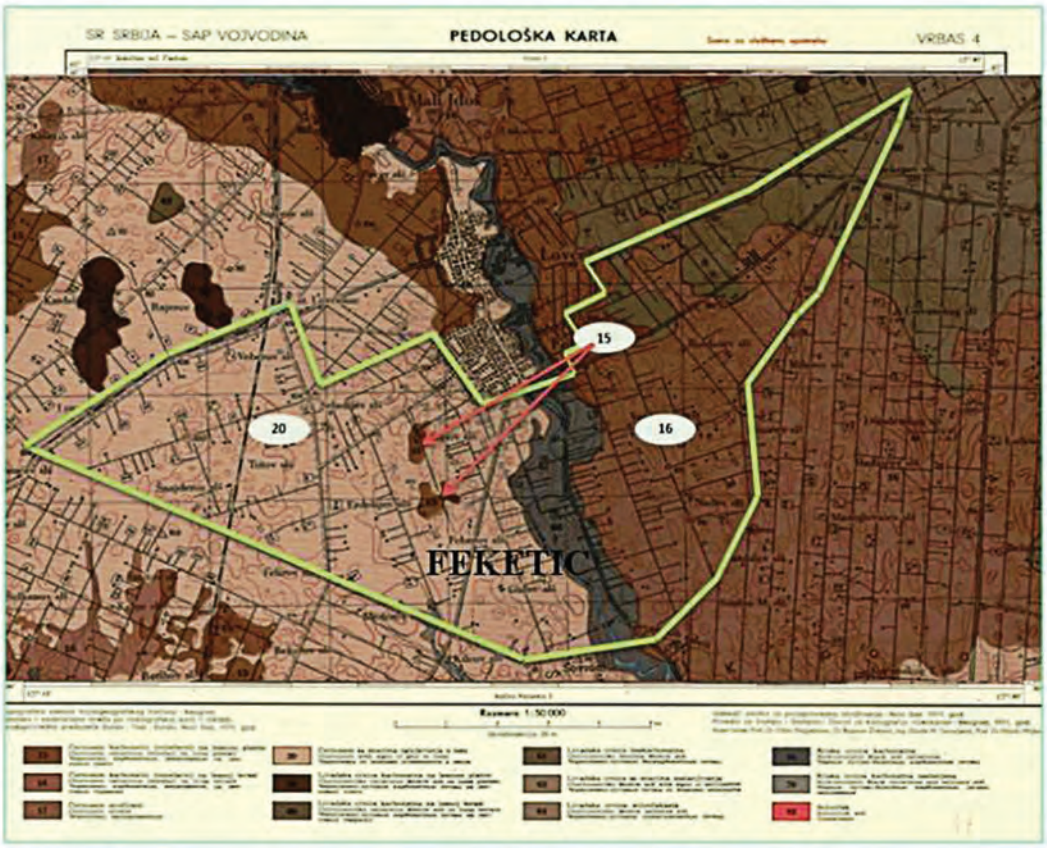


Figure 5: Pedology map for the land consolidation area of CM Feketic, with presentation of main soil types.

Spatial analysis of agricultural land use was performed in the Arc GIS 9.0 software environment, using cadastral classification data from the *Real Estate Cadastre database* for the territory of CM Feketic, and the land consolidation valuation performed using standard methodology (Figures 6a–6d).


Figure 6a: Presentation of the 1st class land before land consolidation in CM Feketic (cadastral data).

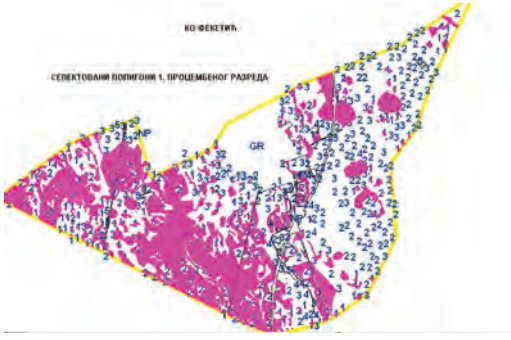


Figure 6b: Land areas with valuation grade 1.


Figure 6c: Presentation of 1st and 2nd class land before land consolidation in SM Feketic (cadastre data).

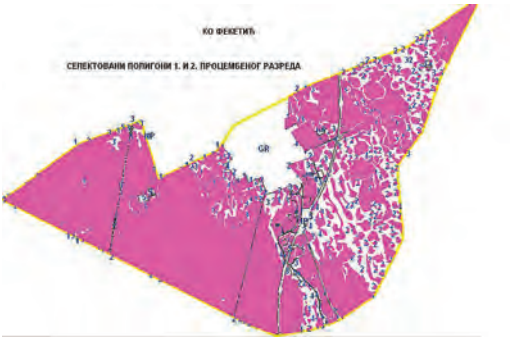


Figure 6d: Land areas with valuation grades 1–2.

Agricultural land classification in Serbia is performed pursuant to Article 17 of the Rulebook on Cadastral Classification and Soil Fertility Valuation (*Official Gazette of RS, No. 63/2014*), using:

- Data on location, quantity, morphology, physical and chemical properties and indication of specimen soil for the territory of the county, i.e. the cadastral municipality where the cadastral classification is performed (*Paragraph 1 of the Rulebook*);
- Determination of natural and economic production conditions, i.e. by taking over municipal data on climate elements, yields, hydrology, etc. (*Paragraph 5 of the Rulebook*).

Within the framework of spatial analysis in the GIS environment, 333 geo-located soil profiles were analysed in the study area considering relief and landscape of the land consolidation area (Figure 7).

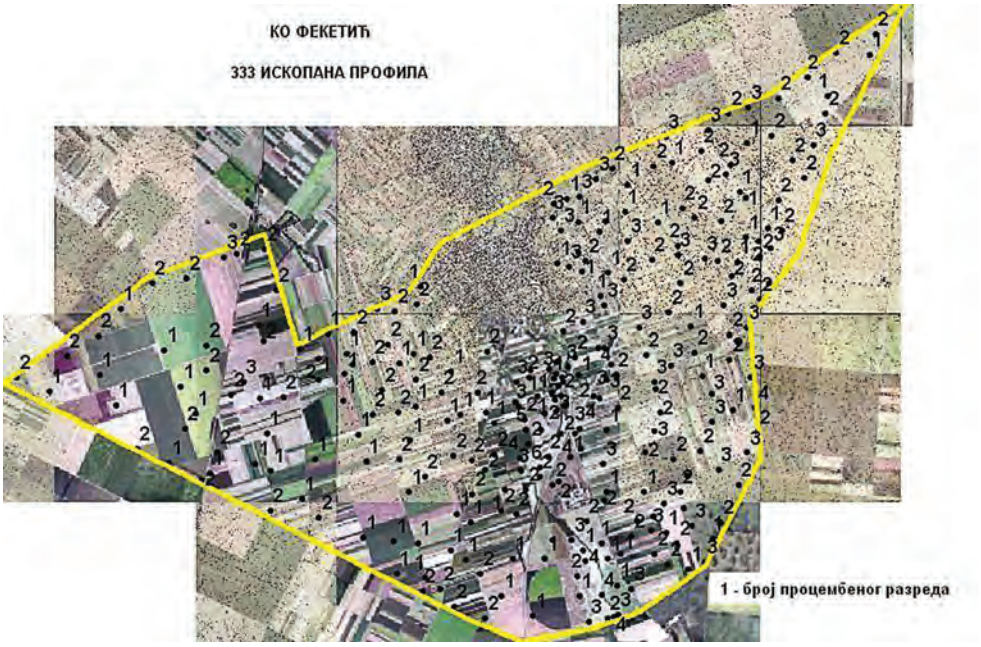


Figure 7: Orthophoto of the land consolidation area in CM Feketic with soil profiles.

## 4.2 Statistical analysis

Statistical analysis of the number of land parcels or their parts (polygons) per valuation grades and their area in the GIS environment resulted in the conclusion that the majority of polygons had relatively small areas before land consolidation in the study area, up to 1 hectare, thus indicating land fragmentation through numerous small cadastral parcels, reflected also in the agricultural land use (Figure 8).

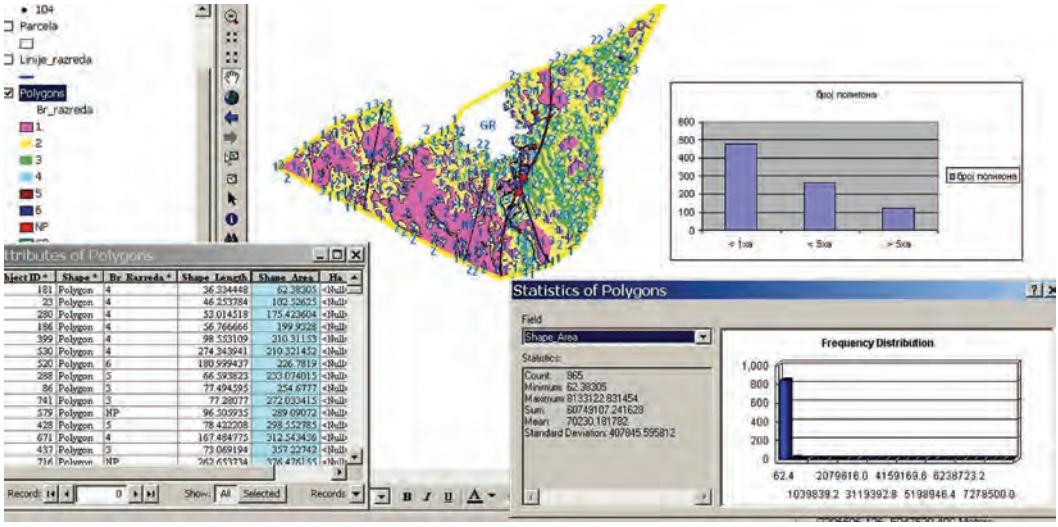


Figure 8: Presentation of land classification by valuation grades' areas in CM Feketic.

GIS was further used for the analysis of individual polygons' areas for each valuation grade (1–6) of agricultural land. A total of 865 polygons were covered over the territory of 6065 hectares (study area). Areas were ranging from 65 $m^2$ to 831 hectares. Polygons with extremely small areas against those with large areas would indicate extreme terrain relief shifts, without reviewing the terrain topography. The GIS analysis, statistical analysis of valuation grades 1, 2 and 3, altitude and overview of relief data (orthophoto) indicate lowland relief, with moderate continental climate and agricultural production (as shown in Figure 3).

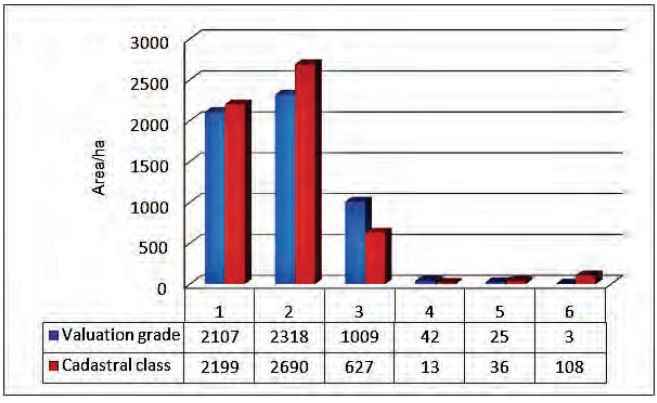


Figure 9: Presentation of land areas for valuation grades and cadastral classes in CM Feketic.

Figure 9 presents, in parallel, the area of agricultural land for the individual cadastral class (1–6) in the study area and the area of land for the individual valuation grades (1–6) used for agricultural land classification for the purpose of the land consolidation process. The analysis presented indicates the stability of soil quality (no flooding or other erosive events) and quality of the *Real Estate Cadastre* data when considering data on agricultural land classification in the framework of the official real estate cadastre. Graphical presentation of comparative analyses of agricultural land classification in the *Real Estate Cadastre* and evaluation of agricultural land for the purpose of land consolidation in the study area is shown in Figures 6a–6d. The consequence of agricultural land classification into a number of polygons per valuation grades in the field without prominent relief changes might cause a new land fragmentation in the process of land consolidation, as indicated by the GIS analysis.

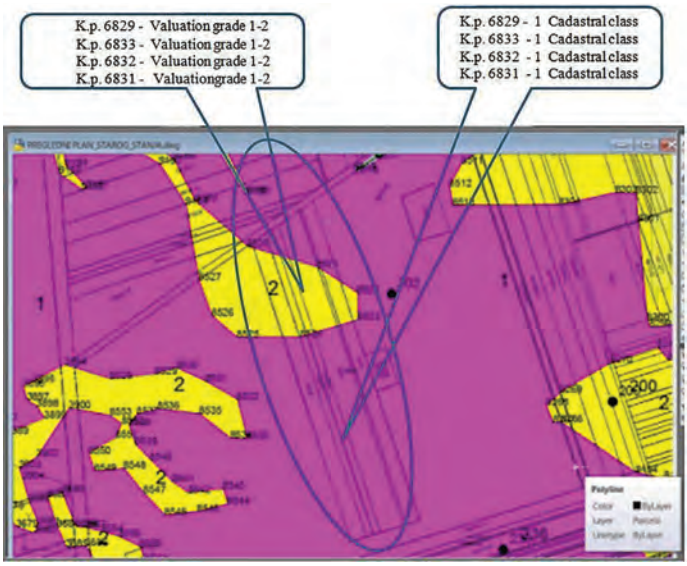


Figure 10: Presentation of cadastral land parcels and areas with the same valuation grades.

Figure 10 shows an example of cadastral classes' fragmentation in the land consolidation procedure when considering the quality of soil, i.e. agricultural land. The agricultural parcels shown have the best soil quality and are classified as the 1st cadastral class in the *Real Estate Cadastre.* In the process of land consolidation, the classes of soil quality have been reduced and land parcels were classified into two valuation grades – first (dark) and second (bright). The soil profile for the second valuation grade is not conducted, thus indicating the need for additional land consolidation parameters to verify the determination of the valuation grade.

In the land consolidation procedure, for optimizing land rearrangement and determining new cadastral classes to the new land plots, by selecting representative soil profiles and determining boundaries of valuation grades, GIS technology would be of great use, as shown in this paper.

## 5 RESEARCH ANALYSIS AND RESULTS

The research performed was aimed at improving agricultural land valuation within the land consolidation procedure. The primary and secondary objectives were (i) to provide a land valuation procedure that

may be repeated through several iterations, and (ii) to improve determination of boundaries between valuation grades by using GIS technology and available digital geospatial databases.

Research analyses and the results can be presented in the following steps:

- *An approximate land valuation map* in digital format needs to be produced during the preparatory works of land valuation for the land consolidation, using raster or vector pedology, topology and geology maps, remote sensing data (satellite images, orthophoto), and land information collected in the land consolidation area (landfills, protected sites, draining, drainage system);
- A water logging map and a map of protected areas (landscape) in digital format need to be produced (as a separate layer), to be merged with an approximate land valuation map;
- Geolocation of soil profiles (designing) on the approximate land valuation map is to be performed during the preparatory works phase, based on the land use map per classes from the *Real Estate Cadastre* database, in line with The instructions on Geodetic-Technical Works and Determination of Land Value in the Land Consolidation Process (*Official Gazette of the RS, No. 3/1977*) and the Rulebook on Cadastral Classification and Soil Fertility Valuation (*Official Gazette of the RS, No. 63/2014)*.
- Collection of information on land consolidation regarding limitations, and optimizing the factors of natural soil fertility, to be integrated with the database of an approximate land valuation map;
- Producing the map of soil profiles in the GIS environment, aiming at definition of optimal boundaries and polygons of valuation grades, and compared with the Serbian standards for soil profile and location description, especially regarding soil structure, humus classes, bulk density, carbonate content and surface layer pH;
- Supplement the designed orientation map of land valuation by data on organic matter content, crop available water in the root zone and hydrological conductivity*;*
- The orientation land valuation map is to be produced iteratively, until it is accepted by the sub -commission for land consolidation valuation, especially when defining selection of representative soil profiles, profile descriptions in line with the current standards, accompanying technical documentation, and classification of soil samples' analyses.



## 6 CONCLUSIONS

The integration of the *Real Estate Cadastre* alphanumerical data, digital graphical spatial databases (vector and raster) and field measurements (GNSS technology) was used as the basis for spatial analysis, soil profiles' positioning, and graphical presentation of the results in the agricultural land appraisal procedure within land consolidation in the study area. The spatial statistical analysis indicates the trends of land valuation grades' grouping considering relief characteristics, while other factors were not considered, leaving room for further research.

Based on the results, final considerations may be given regarding the significant application of geographic information systems and new surveying technologies in the acquisition, analysis and valuation of attributes, which are important for the agricultural land appraisal. Graphical and vector data, stored in the official digital spatial databases, such as the *Real Estate Cadastre*, are nowadays the foundation of decision making. When using these data in the GIS project, the critical and suitable use requires data quality control as well as the acquisition of a certain amount of new data. The complexity and quality of data used are reflected

in the analysis, and determine the accuracy of the results obtained. This fact has to be considered also by GIS applications for agricultural land appraisal procedure within the land consolidation.

Regulations and procedures for the land valuation procedure within land consolidation are very important, both from methodological and legal points of view. Amendments to the legislation in the field of land valuation for the land consolidation procedure have to provide the legal basis for improving the proposed land valuation methodology in the GIS environment, and the application of GIS techniques and technology as the primary tool in the procedure of agricultural land valuation for land consolidation.

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