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# APPLICATION OF COPRAS METHOD FOR LAND CONSOLIDATION PROJECTS RANKING

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RESUME

Each local, self-government unit which is planning to develop and later implement the project of land consolidation is confronted with the problem of choosing the cadastral municipality for land management via land consolidation. The appliance of multi-criteria decision method enables and helps the decision makers to act regularly and correctly when making a decision. Multi-criteria analysis, above all, enables decision making in conflict conditions. These conditions include multiple alternatives and criteria, from which some should be maximized, and others minimized. This paper deals with the problematic of the ranking of cadastral municipalities in which land management should be performed with the use of land consolidation, by applying COPRAS method. The paper also presents the evaluation of the defined model in the Municipality of Pećinci.

Key words: *cadastral municipality, land consolidation, projects ranking*

## INTRODUCTION

Land consolidation represents a planned process which regulates the lots management as well as the property over them [1]. According to the Agricultural Land Act [2], land consolidation is defined as a process which incorporates planned, organizational, legal, economic, and technical measures which are implemented for the purpose of enlargement and improvement of natural and ecological terms on the land. The main goal of land consolidation has always been enlargement of agricultural properties in the smallest possible number of fine-shaped lots, in order to improve primary agricultural production and promote its development.

In time, however, land consolidation obtained a more complex form, so according to [3,4,5,6,7,8,9], land consolidation today represents an important approach to sustainable development. It started with the primary goal of increasing arable agricultural land, and developed in an important instrument for the overall management and development of urban and rural areas.

By perceiving the significance and benefits which land consolidation projects bring to the development of the area, as well as the limited financial funds for the realization of the projects in the Republic of Serbia, it is clear that the choice of cadastral municipalities must include those which demand a greater need for land territory management, i.e. it is necessary to perform the ranking of cadastral municipalities according to certain criteria.

The solution of this problem is presented with the methods of multiple-criteria optimization, which enable the ranking performance based on the real data about cadastral municipalities, obtained from relevant institutions (Republic Geodetic Authority, Statistical Office, Municipalities, etc.). Hence, according to [10] the perpetuation and exactness of real estate cadastre significantly affects the realization of land consolidation projects - primarily those related with the realization of hydromelioration, for which land consolidation is the simplest tool.

Projects from the field of land consolidation are high-demanding and imply significantly large financial investments. Considering the general characteristics of these projects, it remains clear that unequivocal decision making, providing of funds and setting priorities when choosing municipalities and cadastral municipalities for agricultural land management with land consolidation, are an imperative [11].

By applying multi-criteria decision making methods, the Local Self-Government Units are provided with multiple alternatives which need to be ranked according to a certain number of criteria. While performing the ranking, some conflict terms develop when some criteria should be maximized, and other should be minimized. To solve this problem, instruments more flexible than mathematical techniques of pure optimization are applied. One of such methods is COPRAS.

Land consolidation projects are ranked according to the following procedure [12]

- Defining of the ranking criteria;
- Calculating of quantitative indicators for the selected criteria;
- Data normalization, which provides equalization;
- Evaluation of weight coefficients;
- Ranking of projects with the help of multi-criteria analysis.

The listed steps are applied by all multi-criteria methods, whereby some of the most frequently used are described in the paper [13]. Methods of multi-criteria analysis are used in many spheres of life and science. Nowadays, land consolidation is incomprehensible without sustainable development, where the methods of multi-criteria analysis are also used [14].

The object of this paper's research is the launching of land consolidation projects and their characteristics, with the goal of obtaining a full and real image which will further serve as a foundation for objective defining of the model and for suggesting relevant criteria for the ranking of cadastral municipalities. This paper also focuses on COPRAS method of multi-criteria analysis and its appliance in the ranking of land consolidation projects.

The paper defines the model of multi-criteria decision making with the use of COPRAS method. The use of a suggested model, serving as particular back-up tool for decision making process, aims to decrease the risk of wrong decision making and to make the whole process significantly more objective and effective.

The basic and primary goal of the research is to define the multi – criteria optimization model, based upon which objective ranking of land consolidation projects for agricultural land management by land consolidation in the Municipality of Pećinci will be performed. This way, with planned design and realization of land consolidation projects, the conditions for more economical and efficient agricultural production in rural areas are created, which directly affects the development and prosperity of local communities in general.

## MATERIAL AND METHODS

### Material

With the goal of ranking the cadastral municipalities in the Municipality of Pećinci, data considering the state of both property and parcel in the analyzed cadastral municipalities have been gathered. The data have been obtained by relevant institutions and facilities like Republic Geodetic Authority,

Ministry of Agriculture, Forestry and Fisheries, Ministry of Public Administration and Local Self-Government, Statistical Office, and the Local Self-Government Unit of Pećinci. Because of the complexity of the problematic itself, large amount of data was obtained from cadastral municipalities during the research. Thus, their presentation here will be left out.

**Optimization model of land consolidation projects**

In order to formulate the optimization model, it is necessary to define the goal, criteria, and the alternatives. The model's goal is to rank cadastral municipalities (alternatives – 15 cadastral municipalities) in the Municipality of Pećinci, i.e. to determine the order of the priorities for agricultural land management with land consolidation in the mentioned municipality. An approach described in the paper was used to define the optimization model [11].
Defining of the model was conducted through several steps:

1. Defining of goal functions (criteria).
2. Defining of the weights of individual criteria.
3. Defining of the decision matrix for the ranking of cadastral municipalities.
4. Applying of the mathematical model of COPRAS method.

**Defining of goal functions (criteria)**

In the goal of determining of the optimal cadastral municipality, that is of their ranking for the realization of land consolidation projects in the Municipality of Pećinci, and based on the analysis of numerous research and scientific literature, a team of experts from the field of land consolidation from the Faculty of Technical Sciences in Novi Sad defined and suggested relevant criteria for the ranking:

$f1$ : Share of arable land in the total agricultural land surface;
$f2$ : Average parcel surface in out-of-construction area;
$f3$ : Number of parcels per real estate folio;
$f4$ : Average property surface in out–of–construction area:
$f5$ : Percent of individual agricultural manufacturers with property size larger than 5 hectares;
$f6$ : State property share in the total out–of–construction area surface;
$f7$ : Size of the state property land, given in lease;
$f8$ : Surface under channel network;
$f9$ : Active agricultural population;
$f10$ : State of land consolidation.

Criteria are reasoned in a way described in the following text.

- Share of arable land in the total agricultural land surface. Grouping of the land through the realization of land consolidation projects refers exclusively on arable land (fields). Larger percent of arable land in the total municipality surface clearly indicates on the greater land consolidation effects [11]. This function is maximized in the optimization process.

- Average parcel size in out-of-construction area. Area fragmentation and the average parcel size have always been obstacles for agricultural development. Size and shape of the parcels in fragmented households often doesn't allow the rational use of modern mechanization. Additionally, it is also a very significant loss of time to transfer the mechanization from one parcel to another. Such a disarranged property can't be rationally processed, so there are no incomes which could be realized if the property was arranged properly. The priority in ranking should be given to cadastral municipalities in which the average lot size in private property is smaller, with the goal of gaining a larger surface [11]. This function is minimized in the optimization process.

- Number of parcels per real estate folio. One if the most important goals of land consolidation is to reduce the number of parcels with land consolidation participants, that is, to make the participants have their property on the smallest possible number of places in the land

consolidation area after the land consolidation project is realized. With a higher number of parcels per real estate folio, the land consolidation effects also increase. This function is maximized in the optimization process [15].

- Average property size in out–of–construction area. Average property size in an out–of–construction area is a significant factor because of a simple reason – the process of land consolidation doesn't make any sense when the average size of the property is small. With a larger average property size in an out-of-construction region, the land consolidation effects also increase. This function is maximized in the optimization process [15].

- Percent of individual agricultural manufacturers with property size larger than 5hectares. Small, family-type households, whose development was restrained for too long by the most diverse restrictive measures, have the tendency to completely vanish in perspective. The following groupings, classified per property size, have an effect on the creation of market economy [16]:

1. Agricultural households with property size up to 3 ha will have problems with existence in the future as well. It is presumed that members of these households will gain employment in other households, other sectors of economy, or they will be directed on intensive production of vegetables, fruit, special cultures, etc.

2. Agricultural households with property size from 3-5 ha (the most numerous today) will still vegetate on the verge of existence from working in agriculture. They will strive to increase their property or seek an employment outside of agriculture.

3. Agricultural households with property size from 5-10 ha have the preconditions for economic prosperity if they leave the so-far "everything and anything" production and acquire an important progress in household modernization.

4. Agricultural households with property size over 10 ha should grow into a basic carrier of modern market manufacture on the country. This function is maximized in the optimization process.

    - State property share in the total surface of out–of–construction area. The land users in state property are the Ministry of Agriculture, Forestry and Fisheries, Local Self-Government Units, Local Communities, etc. The users of agricultural land in state property actualize significant incomes, which in the vast majority of cases enable the "survival" of individual Local Self-Government Unit. Thus, it is clear that land consolidation effects are greater when the surface of state land increases [11]. This function is maximized in the optimization process.

    - Size of the state property land, given in lease. A serious source of incomes for the vast majority of municipalities on the territory of AP Vojvodina is represented by giving agricultural land in lease. However, certain problems in the realization of the lease are represented by fragmented and scattered land, inaccessible parcels, non-existing irrigation and drainage systems, etc. Land consolidation should provide better conditions for agricultural production to future tenants, which would enable organs of local self-government a more efficient lease of land and acquiring of a better lease profit [11]. This function is maximized in the optimization process.

    - Surface under channel network. Without a functional channel network, agricultural production occurs somewhat difficult, due to the lack of possibility for draining away the extra water from arable land. Besides for drainage, channel network may also serve for irrigation. The simplest solution for the problem of water regime regulation is performed through the process of land consolidation, by setting up a new channel network. The smaller is the surface under channel network, the larger will the effects of land consolidation be [16]. This function is minimized in the optimization process.

- Active agricultural population. Due to the industrialization process, that overtook the whole country by the end of seventies and in the early eighties of the XX century, intensive deagrarization took place. If we include a very poor status of individual agricultural manufacturers as well as the impossibility of providing basic conditions and resources necessary for modern living, we have more than enough reasons to improve the conditions through land consolidation, at least to those who decided to do agriculture despite of generally poor agricultural situation [11]. This function is maximized in the optimization process.

- State of land consolidation. This criterion is specific because it represents the only qualitative criteria. It is evaluated descriptively: the land consolidation is, or not performed in the CM (Cadastral Municipality). In order to include this criterion in the optimization, it is necessary to perform its quantification, that is - to determine a scale which will replace descriptive ranks. The quantification was performed with 0 – 1 scale, so that the CM's in which the land consolidation was performed receives the value 0, while the CM's in which land consolidation wasn't performed receives the value 1. The land consolidation effects will be greater in the CM's in which land consolidation was not performed. This function is maximized in the optimization process [15].

**Defining of the weights of individual criteria**

When there are several unequally important criteria involved in the process of decision making, it is necessary to assign them weights (weight factors, i.e. values), which reflect their relative importance. The weights serve for defining the significance of the participation of individual criteria while making a decision on the choice of the most favorable alternative solution of the problem.

In this paper, weight values of the criteria are determined with applying AHP consensus model. Mathematical model of the applied method is described in the paper [17], so its detailed description is hereby left out.

**Defining of the decision matrix for the ranking of cadastral municipalities (CMs)**

After assigning weight coefficients to the criteria, it is necessary to form decision making matrix. Table 1 depicts decision matrix for the ranking of cadastral municipalities on the territory of the Municipality of Pećinci, for agricultural land management with land consolidation.

Table 1. Decision matrix

| Criteria | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Unit | % | ha/lot | lot/LN | ha/LN | % | % | % | m/ac | % | N.br. |
| Weight | 0.216 | 0.216 | 0.049 | 0.084 | 0.139 | 0.049 | 0.084 | 0.049 | 0.084 | 0.031 |
| Goal | max | min | max | max | max | max | max | min | max | max |
| Alternative | | | | | | | | | | |
| Ašanja | 75.30 | 1.40 | 3.08 | 4.32 | 8.89 | 36.31 | 54.54 | 28.36 | 46.61 | 0.00 |
| Brestač | 81.64 | 1.11 | 3.02 | 3.35 | 17.70 | 10.42 | 29.94 | 46.30 | 74.61 | 1.00 |
| Deč | 70.53 | 1.55 | 2.02 | 3.12 | 8.27 | 24.60 | 72.72 | 39.24 | 29.90 | 0.00 |
| D. Tovarnik | 86.98 | 1.46 | 3.51 | 5.11 | 19.85 | 33.74 | 75.98 | 39.98 | 46.25 | 0.00 |
| Karlovčić | 77.11 | 1.16 | 3.74 | 4.33 | 16.64 | 27.30 | 76.36 | 44.31 | 35.47 | 0.00 |
| Kupinovo | 16.70 | 3.50 | 3.39 | 11.88 | 7.42 | 79.62 | 0.16 | 9.59 | 43.92 | 0.00 |
| Obrež | 27.96 | 4.92 | 3.15 | 15.50 | 12.35 | 56.14 | 6.32 | 43.67 | 50.87 | 0.00 |
| Ogar | 54.78 | 2.04 | 3.31 | 6.76 | 11.61 | 48.92 | 32.07 | 46.11 | 45.50 | 0.00 |
| Pećinci | 80.63 | 0.58 | 3.44 | 2.01 | 9.50 | 13.40 | 6.48 | 28.33 | 25.28 | 1.00 |
| Popinci | 75.18 | 0.77 | 3.42 | 2.64 | 11.39 | 6.87 | 27.04 | 17.91 | 65.84 | 1.00 |
| Prhovo | 71.21 | 0.74 | 3.85 | 2.87 | 10.99 | 15.12 | 87.66 | 35.69 | 65.48 | 1.00 |
| Sibač | 85.11 | 1.26 | 3.52 | 4.45 | 19.85 | 26.13 | 53.89 | 42.79 | 61.50 | 0.00 |
| S. Mihaljevci | 81.70 | 1.05 | 3.63 | 3.82 | 16.52 | 16.58 | 55.19 | 37.13 | 65.91 | 1.00 |
| Subotište | 86.27 | 1.52 | 2.66 | 4.05 | 16.06 | 24.91 | 64.18 | 40.14 | 54.96 | 0.00 |
| Šimanovci | 67.57 | 1.04 | 2.78 | 2.90 | 11.63 | 10.04 | 42.89 | 10.37 | 20.18 | 0.00 |

**Mathematical model of COPRAS method**

Mathematical model of COPRAS method includes several steps [18]:

- ***Step 1*** - Formation of the normalized decision matrix $R=[r_{ij}]_{mxn}$. Normalization of the values of decision matrix elements is performed by linear transformation – the Sum method, where the values $r_{ij}$ are determined by applying the formula:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, i = 1,...m,\ j = 1,...n \tag{1}$$

where:
$x_{ij}$ - performance of the ith alternative in relation to jth criteria/attribute
m – number of alternatives
n – number of criteria/attributes.

- ***Step 2*** - Formation of the weight-normalized decision matrix $V = \lfloor V_{ij} \rfloor_{mxn}$. Weight-normalized value $v_{ij}$ is calculated by applying the formula:

$$v_{ij} = w_j \times r_{ij}, i = 1,...m,\ j = 1,..n \tag{2}$$

where $w_j$ represents the weight or significance of the $j^{th}$ criteria/attribute, whereby the following condition must be valid $\sum_{j=1}^{n} w_{ij} = 1$ .

- ***Step 3*** – Calculation of Pi (max) and Ri (min) , by the following formulas:

$$P_i = \sum_{j=1}^{n} v_{ij} \mid j \in j^{\max}, i = 1,...m \tag{3}$$

$$R_i = \sum_{j=1}^{n} v_{ij} \mid j \in j^{\min}, i = 1,...m \tag{4}$$

where $j^{max}$ represents the sum of maximal criteria/attributes, and $j^{min}$ is represented with the sum of minimal criteria, that is attributes.

- ***Step 4*** - Determining of the relative significance (weight) for each alternative. The relative importance of the alternatives, $Q_i$, is determined by applying the formula:

$$Q_i = 1 + \frac{\sum_{i=1}^{m} R_i}{R_i \times \sum_{i=1}^{m} \frac{1}{R_i}}, i = 1,... m \tag{5}$$

- **Step 5** – The choice of the best alternative, or the ranking of alternatives. The considered alternatives are ranked in a growing line, according to the value $Q_i$, and the best alternative A is determined by applying the following formula:

$$A^* \in \{A_i^* \mid = \max Q_i\} \tag{6}$$

RESULTS

In this paper, the weight values of the defined criteria are determined by applying the AHP consensus model. In the defined model, the acquired consistency index is 0.0081, which means that the result is

sufficiently accurate and that there is no need for corrections in comparisons and for repeating of the calculations.

For the goal of obtaining a list of priorities of cadastral municipalities for agricultural land management by land consolidation, a mathematic model of the COPRAS method is applied to the decision-making matrix (table 1) with weights of the criteria determined by using AHP consensus model. The following text presents the results obtained with applying of COPRAS method for the ranking of cadastral municipalities in the Municipality of Pećinci.

Table 2 presents normalized decision matrix, and table 3 presents weight-normalized decision matrix. In the next step, values Pi (max) and Ri (min) were obtained and presented in table 4.

The following step helps to determine the relative significance (intensity) for each alternative. After that, the ranking of alternatives was performed, whereby the best ranked CM has the greatest intensity. The obtained ranks were sorted per cadastral municipalities which have the priority for agricultural land management via land consolidation, and are presented in table 5, where the rank number 1 presents the best ranked CM.

Table 2. Normalized decision matrix

| | f1 | f2 | f3 | f4 | f5 | f6 | f7 | f8 | f9 | f10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ašanja | 0,072 | 0,058 | 0,064 | 0,056 | 0,045 | 0,084 | 0,080 | 0,056 | 0,064 | 0,000 |
| Brestač | 0,079 | 0,046 | 0,062 | 0,043 | 0,089 | 0,024 | 0,044 | 0,091 | 0,102 | 0,200 |
| Deč | 0,068 | 0,064 | 0,042 | 0,040 | 0,042 | 0,057 | 0,106 | 0,077 | 0,041 | 0,000 |
| D. Tovarnik | 0,084 | 0,060 | 0,072 | 0,066 | 0,100 | 0,078 | 0,111 | 0,078 | 0,063 | 0,000 |
| Karlovčić | 0,074 | 0,048 | 0,077 | 0,056 | 0,084 | 0,063 | 0,111 | 0,087 | 0,048 | 0,000 |
| Kupinovo | 0,016 | 0,145 | 0,070 | 0,154 | 0,037 | 0,185 | 0,000 | 0,019 | 0,060 | 0,000 |
| Obrež | 0,027 | 0,204 | 0,065 | 0,201 | 0,062 | 0,131 | 0,009 | 0,086 | 0,069 | 0,000 |
| Ogar | 0,053 | 0,085 | 0,068 | 0,088 | 0,058 | 0,114 | 0,047 | 0,090 | 0,062 | 0,000 |
| Pećinci | 0,078 | 0,024 | 0,071 | 0,026 | 0,048 | 0,031 | 0,009 | 0,056 | 0,035 | 0,200 |
| Popinci | 0,072 | 0,032 | 0,071 | 0,034 | 0,057 | 0,016 | 0,039 | 0,035 | 0,090 | 0,200 |
| Prhovo | 0,069 | 0,031 | 0,079 | 0,037 | 0,055 | 0,035 | 0,128 | 0,070 | 0,089 | 0,200 |
| Sibač | 0,082 | 0,052 | 0,073 | 0,058 | 0,100 | 0,061 | 0,079 | 0,084 | 0,084 | 0,000 |
| S. Mihaljevci | 0,079 | 0,044 | 0,075 | 0,049 | 0,083 | 0,039 | 0,081 | 0,073 | 0,090 | 0,200 |
| Subotište | 0,083 | 0,063 | 0,055 | 0,053 | 0,081 | 0,058 | 0,094 | 0,079 | 0,075 | 0,000 |
| Šimanovci | 0,065 | 0,043 | 0,057 | 0,038 | 0,059 | 0,023 | 0,063 | 0,020 | 0,028 | 0,000 |

Table 3.Weight-normalized decision matrix

| | f1 | f2 | f3 | f4 | f5 | f6 | f7 | f8 | f9 | f10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ašanja | 0,016 | 0,013 | 0,003 | 0,005 | 0,006 | 0,004 | 0,007 | 0,003 | 0,005 | 0,000 |
| Brestač | 0,017 | 0,010 | 0,003 | 0,004 | 0,012 | 0,001 | 0,004 | 0,004 | 0,009 | 0,006 |
| Deč | 0,015 | 0,014 | 0,002 | 0,003 | 0,006 | 0,003 | 0,009 | 0,004 | 0,003 | 0,000 |
| D. Tovarnik | 0,018 | 0,013 | 0,004 | 0,006 | 0,014 | 0,004 | 0,009 | 0,004 | 0,005 | 0,000 |
| Karlovčić | 0,016 | 0,010 | 0,004 | 0,005 | 0,012 | 0,003 | 0,009 | 0,004 | 0,004 | 0,000 |
| Kupinovo | 0,003 | 0,031 | 0,003 | 0,013 | 0,005 | 0,009 | 0,000 | 0,001 | 0,005 | 0,000 |
| Obrež | 0,006 | 0,044 | 0,003 | 0,017 | 0,009 | 0,006 | 0,001 | 0,004 | 0,006 | 0,000 |
| Ogar | 0,011 | 0,018 | 0,003 | 0,007 | 0,008 | 0,006 | 0,004 | 0,004 | 0,005 | 0,000 |
| Pećinci | 0,017 | 0,005 | 0,003 | 0,002 | 0,007 | 0,002 | 0,001 | 0,003 | 0,003 | 0,006 |
| Popinci | 0,016 | 0,007 | 0,003 | 0,003 | 0,008 | 0,001 | 0,003 | 0,002 | 0,008 | 0,006 |
| Prhovo | 0,015 | 0,007 | 0,004 | 0,003 | 0,008 | 0,002 | 0,011 | 0,003 | 0,008 | 0,006 |
| Sibač | 0,018 | 0,011 | 0,004 | 0,005 | 0,014 | 0,003 | 0,007 | 0,004 | 0,007 | 0,000 |
| S. Mihaljevci | 0,017 | 0,009 | 0,004 | 0,004 | 0,012 | 0,002 | 0,007 | 0,004 | 0,008 | 0,006 |
| Subotište | 0,018 | 0,014 | 0,003 | 0,004 | 0,011 | 0,003 | 0,008 | 0,004 | 0,006 | 0,000 |
| Šimanovci | 0,014 | 0,009 | 0,003 | 0,003 | 0,008 | 0,001 | 0,005 | 0,001 | 0,002 | 0,000 |

Table 4. Presentation of gained values Pi (max) and Ri (min)

| Alternative | Pi (max) | Ri (min) |
|---|---|---|
| Ašanja | 0,046 | 0,015 |
| Brestač | 0,056 | 0,014 |
| Deč | 0,041 | 0,018 |
| Donji Tovarnik | 0,060 | 0,017 |
| Karlovčić | 0,053 | 0,015 |
| Kupinovo | 0,039 | 0,032 |
| Obrež | 0,047 | 0,048 |
| Ogar | 0,045 | 0,023 |
| Pećinci | 0,040 | 0,008 |
| Popinci | 0,048 | 0,009 |
| Prhovo | 0,056 | 0,010 |
| Sibač | 0,057 | 0,015 |
| Sremski Mihaljevci | 0,059 | 0,013 |
| Subotište | 0,053 | 0,017 |
| Šimanovci | 0,037 | 0,010 |

Table 5. Ranking list of cadastral municipalities – COPRAS method

| Alternative | Intensity | Rank |
|---|---|---|
| Prhovo | 0,081 | 1 |
| Sremski Mihaljevci | 0,078 | 2 |
| Popinci | 0,077 | 3 |
| Donji Tovarnik | 0,074 | 4 |
| Brestač | 0,073 | 5 |
| Sibač | 0,073 | 6 |
| Pećinci | 0,072 | 7 |
| Karlovčić | 0,070 | 8 |
| Subotište | 0,068 | 9 |
| Ašanja | 0,062 | 10 |
| Šimanovci | 0,061 | 11 |
| Ogar | 0,056 | 12 |
| Deč | 0,055 | 13 |
| Obrež | 0,053 | 14 |
| Kupinovo | 0,047 | 15 |

## DISCUSSION AND CONCLUSION

Multi-criteria analysis and decision making methods became an inevitable segment of planning, management and operative handling in all spheres of life process. There is a significant number of developed multi-criteria analysis methods, and each of them helps the decision maker to solve complex problems. The area involving launching of land consolidation projects soon portrayed the necessity for multi-criteria optimization.

This happened due to an increased interest of the Republic of Serbia and local self-management organs for management of agricultural land by land consolidation, and on the other hand – due to limited resources. Thus, the appliance of these methods is a solution which will help the decision makers to choose which municipalities and cadastral municipalities should have the priority for launching and realization of land consolidation projects.

While giving the priority to a single project from a group of land consolidation projects, the decision maker (Municipality) faces with the problem of the existence of several factors which affect the final decision. Thus, there is often a situation which includes a conflict among criteria, that is, individual ranking by different criteria provides different ranking order of land consolidation projects.
Making a decision based upon just one criterion, without considering the rest of them, questions the accuracy, so that kind of decision is incomplete and non-objective.

In order to make a proper decision, it is necessary to consider and acknowledge all of the criteria. The simplest way to solve the problem is to apply what are already inevitable methods of multi-criteria optimization.

Methods of multi–criteria analysis are thereby an excellent instrument which helps in incorporating all of the criteria in the final decision. This paper presents one of those methods - COPRAS method.
Optimization model, defined in the paper, was used for solving the problem of setting the priority for cadastral municipalities for agricultural land management with land consolidation in the Municipality of Pećinci.

Comparison of the alternatives according to the criteria was performed with the use of the defined optimization model of the ranking of cadastral municipalities and of the mathematical model of COPRAS method.

By applying COPRAS method on the defined model, the ranking of cadastral municipalities for agricultural land management with land consolidation in the Municipality of Pećinci was performed in a very simple manner.

According to the obtained results, the priority for lunching of land consolidation projects in the Municipality of Pećinci should be given to the cadastral municipality of Prhovo, followed by Sremski Mihaljevci and Popinci. The lowest ranked cadastral municipalities are Deč, Obrež, and Kupinovo.
The suggested methodology, based on the defined model and COPRAS method, may significantly help the decision maker to make a choice of cadastral municipalities for the launching of land consolidation projects.

The methodology may include any number of criteria and offers a more objective, simple, and consistent approach in ranking. This methodology may also be applied in the ranking of different sets of alternative cadastral municipalities. We should also emphasize that the choice of cadastral municipality, depending on the local self–government unit, may be based on different criteria, not just on those we suggested and used in the paper.

The defined optimization model for the choice of cadastral municipalities for launching of land consolidation projects is open for further research, with an objective to improve, and to remove eventual deficiencies. That being said, the future research may develop in the direction of applying different methods of multi-criteria analysis or simultaneous appliance of several different methods combined. Future efforts may also support some extra research and lead to defining and suggesting of new ranking criteria, or eliminating of the ones already suggested.

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LITERATURE

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