

## ANALYSIS OF THE EFFECTS OF MODERN TECHNOLOGIES IN THE REALIZATION PROCESS OF THE LAND CONSOLIDATION

Marina Davidović<sup>1</sup>

Jelena Lazić<sup>2</sup>

Milan Trifković<sup>3</sup>

Nemanja Radojičić<sup>4</sup>

Goran Marinković<sup>5</sup>

Gordana Nataroš<sup>6</sup>

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*Summary:* In this paper, contemporary aspects of land consolidation have been analyzed. The automation of the phases in the realization of the projects of the land consolidation made the entire procedure faster and simpler, thus land consolidation gets the new dimension. The aim of the paper is to present through examples in which way and which extent the emergence of new technologies has influenced on the process of carrying out the land consolidation through all its phases itself. Special emphasis is given on the phase of determining the actual state, the distribution of the land consolidated mass, and the development of road and channel network projects, where automation has proved as very effective.

**Keywords:** land consolidation, automation, phases

### 1. INTRODUCTION

The land consolidation was derived from the Latin word *commasare*, which in translation into the Serbian language means collecting in mass. Many authors give different definitions of land consolidation. According to [1], the land consolidation implies a system of spatial-planning, technical, legal, economic and social measures that

<sup>1</sup> Marina Davidović, master inž. geod., Univerzitet u Novom Sadu, Fakultet Tehničkih Nauka, Trg Dositeja Obradovića 6, Novi Sad, Republika Srbija, tel: +381 21 450 810, e – mail: [marina.davidovic@uns.ac.rs](mailto:marina.davidovic@uns.ac.rs)

<sup>2</sup> Jelena Lazić, master inž. geod., Univerzitet u Novom Sadu, Fakultet Tehničkih Nauka, Trg Dositeja Obradovića 6, Novi Sad, Republika Srbija, tel: +381 21 450 810, e – mail: [lazicjelena@uns.ac.rs](mailto:lazicjelena@uns.ac.rs).

<sup>3</sup> Prof. dr Milan Trifković, dipl. inž. geod., Univerzitet u Novom Sadu, Građevinski fakultet Subotica, Kozaračka 2a, Subotica, Republika Srbija, tel: +381 24 554 300, e – mail: [milantri@eunet.rs](mailto:milantri@eunet.rs)

<sup>4</sup> Nemanja Radojičić, master inž. geod., Geosoft d.o.o., Vladimira Tomanovića 9, Beograd, Republika Srbija, e – mail: [nemanja@geosoft.rs](mailto:nemanja@geosoft.rs)

<sup>5</sup> Doc. dr Goran Marinković, dipl. inž. geod., Univerzitet u Novom Sadu, Fakultet Tehničkih Nauka, Trg Dositeja Obradovića 6, Novi Sad, Republika Srbija, tel: +381 21 450 810, e-mail: [goranmarinkovic@uns.ac.rs](mailto:goranmarinkovic@uns.ac.rs)

<sup>6</sup> Gordana Nataroš, master inž. geod., Gradska uprava grada Zrenjanina, GIS centar, Zrenjanin, Republika Srbija, e – mail: [gordana.nataros@grad.zrenjanin.rs](mailto:gordana.nataros@grad.zrenjanin.rs)

the community undertakes for fundamental improvement of natural, economic and ecological conditions of the land territory with the aim of providing better living and working conditions and environmental protection. Land consolidation involves redistribution of fragmented parcels [2, 3]. According to [4], it is a system that includes planning, organizational, legal, economic and technical measures to be implemented in order to increase and improve the natural and environmental conditions of the land. The author [5] defines the land consolidation as a measure which includes improving the efficiency of agricultural business, improving the state of the environment, creating the preconditions for infrastructure development, creation of national and regional development plans.

In the last few years, in the Republic of Serbia, starting-up and realization of the land consolidation projects have become more and more frequent. Therefore, land consolidation represents an area that is in extreme expansion, and which, according to the amount of funds invested in its launch and realization, represents a significant and serious segment for the units of local self-government and the state itself. Also, farmers and land owners are increasingly interested in actively participating in the projects of land consolidation, through clearly defining their specific requirements and wishes, which also affects the complexity of those projects [6]. Considering the fact that those projects are extremely extensive, including preparation phase and previous works, the elaboration of the main project, the implementation phase and final works, and each of these stages requires a certain period of time, it is clear why the average duration from the early beginning to the realization is 2 to 3 years, and even longer. Regarding the numerous benefits of the land consolidation projects, a very important aspect is the automation of its phases. Using modern technologies, each phase of the consolidation is performed faster, easier, more efficient and more transparent, both to the participants of the land consolidation and to the contractors.

Land consolidation is a measure that will continue to conduct in the future for a long time, due to incorrectly distributed parcels and dissatisfaction of the owners of them. Also, some of the conducted land consolidation projects were 40 years ago, so there is probably a need for re-arranging and adapting the land area to modern working conditions. Therefore, due to the implementation of the land consolidation or reconsolidation of certain areas, it is necessary to analyze all the possibilities of accelerating the entire process, which will make the implementation of the projects of land consolidation easier on a long-term basis.

The aim of the research in this paper is to show the benefits of the land consolidation in general, with an emphasis on the automation of all its phases, through adequate examples of the implemented land consolidation in the cadastral municipality (CM) Radenković.

## 2. SOFTWARE SOLUTIONS IN THE REALIZATION OF THE LAND CONSOLIDATION PROJECTS

According to [7], positive changes resulting from the implementation of the land consolidation can be divided into six main categories:

- available agricultural land,
- size and shape of the plot,
- field roads and accessibility to plots,
- density and connection of irrigation systems and drainage systems,
- types of land use and
- number of parcels per household in the consolidated area.

Accordingly, the research in this paper included certain phases in the process of land consolidation, with emphasis on the importance of software solutions in their implementation, such as: determining the actual state, designing the road and channel network, and forming new plots, respectively. Cadastre municipality (CM) Radenković, located in the north of Mačva and belonging to the municipality of Sremska Mitrovica, was selected to be the subject of analysis in this paper.

### 2.1. Determining the actual state

For the purposes of composing the land consolidation mass, the determination of the actual state for the participants of the land consolidation is carried out. This phase includes tasks related to the settlement of ownership-legal relations and the harmonization of the situation in the cadastral register or land register with actual situation in the field, individually for each participant in the land consolidation. After the verification of the data from the list of ownership and the statement of the owner, a record of the determination of the actual state is composing. The record consist of all changes that occurred in the plot division, the termination of co-ownership relations, the sale, the tramp, the attribution, the deletion, the changes relating to the place of residence, etc [8].

As the Record on actual state becomes the basic document for the further implementation of the land consolidation, it is very important that this phase is carried out with the minimal possibility of mistakes during the input of the necessary data. While all the data were entered manually earlier, which often resulted in operator errors, by automating the process, this phase was significantly improved, especially when considering the number of owners in the area of one cadastral municipality, and the number of records that should be formed. Namely, by using new software, each record is automatically generated based on the database of the Republic Geodetic Authority, as the leading institution that keeps records and provides data. The advantage of automation from the aspect of the owner [6] is that it is possible to automatically display the position of its plots just by entering the number of Record on actual state (Figure 1 - green colored polygons refer to the parcels from Record number 3), which enables them faster and easier managing and for the experts is easier to work with the parties.



Figure 1. Automatic display of the parcels of one owner based on the number of the Record on actual state [9]

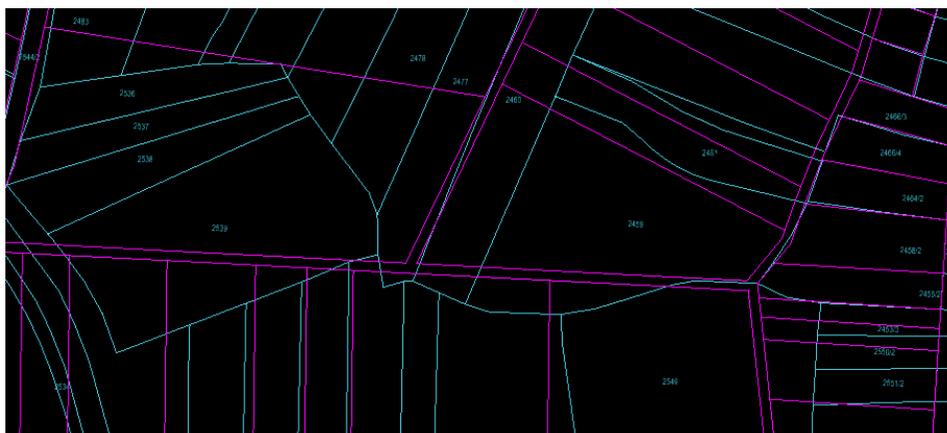
Some of the advantages of this software are that the Book of the mass consolidation fund is automatically generated, it is automatically checked whether any plots remain unallocated to the owner, and whether the plots under the same number are assigned to different owners [6].

## 2.2. Design of road and channel network

In the process of land consolidation, the road and channel network are designed and implemented, which enables easier and better access to the plots, and at the same time the value of the parcels is increased.

According to [10], the roads in the consolidated area should be designed in the way to achieve unobstructed traffic in relation to the neighboring agricultural parcels that are not in the land consolidated area, or to provide easy access to the plots of neighboring parcels, as well as for the needs of local transport. The structure of the network of field roads should satisfy traffic and economic criteria, that only certain corridors provide a traffic flow and that there is a one clear hierarchy.

In order to meet all the criteria for designing the network of channels and roads, it is necessary to have an insight into the complete situation on the ground in terms of the current distribution of the plots, channels, and roads. Technological achievements today facilitate the geodetic experts this phase of land consolidation, where software solutions solve everything easily, quickly and efficiently, and in accordance with the design rules. Figure 2 shows the situation of the design of the road network in the process of land consolidation, for CM Radenković. The figure shows the old boundaries of the plots in blue, while the pink color shows the boundaries of the new plots. It is clear from the figure that earlier on this selected part of the cadastral municipality did not even exist the path between parcels that are irregular in shape, whereas now the parcels are more regular in shape and the path between them exists [11].



*Figure 2. Display of CM Radenković road network before and after land consolidation [11]*

Problems of insufficient efficiency of the drainage system are largely associated with weak maintenance of the channel network and facilities on it. By construction of a lower order channel for drainage of areas in the basins of the main channels, greater use of the land was enabled and it contributed to a certain increase in agricultural production. Further increases are due to the elimination of the causes of incomplete operating effects of existing systems, due to the slow outflow of excess water from agricultural parcels. Acceleration of the drainage process in such conditions is not possible without the use of efficient measures such as an additional channel network, horizontal pipe drainage and agromelioration interventions based on occasional undermining, spreading and other similar measures [12].

The regulation of the drainage system and its realization is based on the possible reconstruction and upgrading of the existing drainage system, while providing the necessary conditions for the application of rapid revulsion of water from agricultural areas and appropriate measures on all humidified areas [12].

The analysis for the development of the channel network in CM Radenković dealt with the agricultural areas on which hydro-melioration systems were previously built, within which there is a possibility for two-way use of water management systems (for drainage

and for irrigation). For creation of the overview map of the studied area (Figure 3), all available geodetic sub-bases were used, as well as the elements obtained from the corresponding technical documentation. Field surveyings defined the bottom and the banks of the channel network in the area of CM Radenković. The processing of all received maps was done by the digitization and by the creation of a georeferenced map [12].

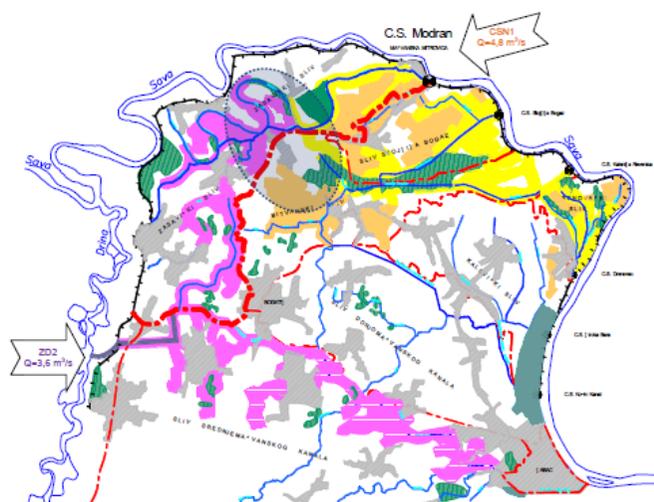


Figure 3. Overview map of the irrigation system in CM Radenković [12]

Since the earlier channel network was designed manually, the development of the project was time-consuming, the possibility of error due to the manual work was high, and the level of detail was insufficient. In order to create a general concept of drainage / irrigation, it is necessary to have maps as much as possible at high scale, and this is without the use of software almost impossible. Today, by process automation and technology advancement, overview of the complete situation of the subjected municipality, as well as its environment, and the regulation of the irrigation and drainage system is facilitated, accelerated and feasible with a significantly higher level of detail. Also, in order to design the channel network, the position of the channels and objects on the ground in the horizontal and vertical level should be marked by the contractor on the basis of the situation plan and longitudinal and transverse profiles on which all elements for marking are given. The required accuracy is extremely high, and therefore, the current software solutions play a major role here as well. It should also be mentioned the great importance of information about the old and the new condition, and the possibility of their overlap, which can compare the difference in the surfaces of the old and new channel network, the distance of a particular path / channel from a particular plot, a number of roads, and all other comparisons as needed.

In the paper [7], the effects of the land consolidation of the mentioned CM were analyzed, indicating that the area under the roads increased by 23ha 34a 47m<sup>2</sup>, and the area under the channel network for 3 ha 64a 73m<sup>2</sup>. Figure 4 shows the new state of road and channel network for the selected part of CM Radenković, where the lines shown in

the blue color form the channel network, and the lines presented in brown are network of new designed roads.



Figure 4. CM Radenković- new state of the road and channel network [13]

## 2.1 Establishment of new parcels

All land area included in consolidation (agricultural, forestry, water, infertility, construction) constitute the consolidated mass taking into account the facilities, devices and equipment on them. The consolidated mass of the old (existing) state is compiled on the basis of the established actual situation and the estimation carried out from Book of the mass consolidation fund of the old state. The Commission allocates the new plots from the consolidated mass to the participants of the land consolidation so that they are formed in correct geometric shape. Each participant of the land consolidation receives the new enlarged plots of the corresponding value, and preferably about the same distance from the settlement, road and water, as well as with the position that provides approximately equal or improved possibilities in terms of access, shape, orientation, which he had on plots before land consolidation [14].

Considering all the above mentioned conditions, in the formation of new plots, ie. in the phase of establishment of new parcels, automation has found an extremely large application, and in a few steps new boundaries of the property are obtained. The process of assignment in the land consolidation is fully automated, and in a few steps new boundaries of the property are obtained. Since it is done by land consolidation boards, the software itself, based on the value of the owner, recalculates how many owners can be found in one land consolidation board and after the formation of new boundaries of the parcels, each parcel is automatically linked to the number of owners and to the Record on the actual state. Also, the software automatically checks whether the conditions for this process are fulfilled by the law, that the value of the certain land does not differ by more than 10% from the value entered into the land consolidated mass, and from the aspect of the area more than 20% [6].

Figure 5 [7] represents an example of parcel grouping after the land consolidation, since it is given a overview of the state before and after land consolidation. In this figure, the

significance of the possibility of layers overlapping and the comparison of the old and the new state is obvious as well.



Figure 5. Comparative overview of the situation of KO Radenkovic before and after land consolidation [7]

### 3. CONCLUSION

Positive results achieved through the land consolidation process relate to improvement of soil integrity, increased yields and reduction of unproductive areas under the boundaries, then the results of the legal character that are essential for the settlement of ownership-legal relations, creating conditions for the establishment of new, up-to-date records of real estate, reducing court cases, etc. By carrying out the land consolidation, a new survey and a real estate cadastre is obtained. Land consolidation has a significant impact on the changing social structure of the village and provides more favorable conditions for the young people to remain in the villages [15].

Land consolidation is given the highest importance in developed countries and great investments are made in its realization, with the appropriate organization of administration, research, application of the latest technologies, etc. It is expected from the future land consolidation projects in the Republic of Serbia to further develop and improve these processes, especially if very significant and versatile effects are taken into account.

This paper presents the effects of software solutions on the performance of individual phases of the consolidation. By analyzing the methods of land consolidation and by examining the conditions before and after this in CM Radenković, which is the subject of the analysis in this paper, it can be concluded that after the arrangement of agricultural land by land consolidation, the following effects have been achieved [7]:

- The number of parcels decreased by 42%
- The area under the road network has been increased by about 3 times

- The area under the channel network has been increased by about 6 times
- Ownership and legal relations on land are solved
- The problem of 36 ha of land under the coast has been resolved
- Renewal of the survey was performed and data are updated

The significance of automation in these phases: determination of the actual state, design of the road and channel network, and the formation of new plots have been elaborated in detail. It is evident how much automation has made the implementation of these phases faster, simpler, more transparent, and in addition to this- with a significantly higher level of detail. Errors of manual entry of data into the database, design of roads and channels, and allocation of new parcels to the users are minimized or completely avoided, because with the appropriate software, and inputting the basic parameters, all this is automatically solved. By reviewing the current state of the art, geodetic experts can understand the complete situation on the field and, if necessary, modify certain data. The possibility of a layer overlap has proved useful, because the old and the new state can be comparative analyzed, in terms of distribution, area, number and position of the plot as well as the road networks, channels, etc. In addition to these effects, the land consolidation as a time-consuming process is accelerated, and therefore the financial costs are lower.

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## АНАЛИЗА ЕФЕКТА МОДЕРНИХ ТЕХНОЛОГИЈА У ПРОЦЕСУ РЕАЛИЗАЦИЈЕ КОМАСАЦИЈЕ

**Резиме:** У овом раду анализирани су савремени аспекти комасације земљишта. Аутоматизација фаза у реализацији пројеката комасације учинила је цео поступак бржим и једноставнијим, чиме комасација добија нову димензију. Циљ рада јесте приказати и кроз примере представити на који начин и у којој мери је појава нових технологија утицала на сам процес извођења комасације кроз све њене фазе. Посебан осврт дат је на фазу утврђивања фактичког стања, расподелу комасационе масе, те израду пројеката путне и каналске мреже, где се аутоматизација показала знатно учинковитом.

**Кључне речи:** комасација, аутоматизација, фазе