Engineering Geodesy in Rural Land Consolidation Procedures in the Republic of Croatia

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Abstract. After the Act on the Agricultural Land Consolidation [OG 51/2015] had been passed, the legal basis was prescribed for re-enforcement of land consolidation on the territory of the Republic of Croatia for the first time after asserting its independence. The Ordinance on Expert Geodetic Works in Land Consolidation [OG 123/2015] regulates the actions in land consolidation procedures carried out by the persons licensed to perform expert geodetic works including the actions from the domain of Engineering Geodesy. Agricultural land consolidation is carried out on the basis of multi-annual and annual programs prepared by the Agricultural Land Agency. This paper gives an overview of activities taken so far concerning conceptual designs for five locations in which land consolidation should be carried out. The focus of the paper is on Engineering Geodesy activities in procedures of land consolidation, such as the design of the road and duct networks and the role in amelioration.

Keywords: Agricultural Land Agency, amelioration, land consolidation, road and duct networks.

1. Introduction

At first glance, it is to be noticed on the cadastral plots of agricultural land that the majority of them are very small with irregular shape and in most cases they do not correspond to the real situation in the field [Figure 1.1]. When we consider unresolved property issues, it is obvious that the situation related to the agricultural land is extremely complex. This kind of situation is one of the major causes of the unprofitability of agricultural production due to small and fragmented agricultural properties that do not provide conditions for successful production in the Republic of Croatia because family farms have the average size of 2.7 ha and are fragmented to approximately 5.3 separated parcels, while in comparison with most European Union countries, the agricultural holdings in Croatia are six times smaller than the average size of agricultural holdings in these countries [Ivković et al. 2008]. Such agricultural holdings are hardly
plausible, and consequently, such land gets abandoned and neglected becoming gradually unsuitable for agricultural production.

A solution that would most effectively eliminate the problem of small and fragmented agricultural holdings and thus eliminate one of the biggest obstacles to the revitalization of the agricultural production in the Republic of Croatia is agricultural land consolidation (hereinafter: land consolidation) [Ivković et al. 2010].

![Figure 1.1 Example of the condition of a part of cadastral map in the cadastral municipality Udbina](image)

2. Agricultural land consolidation

Land consolidation is the agrarian and technical operation intended mostly for collecting scattered holdings that belong to individual households in a single unit, and it is the basic prerequisite for empowering private rural estates and social agricultural organizations to reach more cost-effective production. There are also a number of other technical or legal processes carried out within the scope of land consolidation or related to it, such as land amelioration, renovation of roads, regulation and recovery of settlements, regulation of ownership, production of new cadastral documents and other [Medic 1978]. This is the definition of land consolidation from the period when today’s Republic of Croatia was an integral part of the Federal Republic of Yugoslavia, and due to the changes in social, political and economic relations and the progress of technology, it needs to be modernized, but essentially, the goal remains the same.

Since the Republic of Croatia became independent, there has been no land consolidation performed with no legal basis established ever since for its implementation. According to the annual reports published by the Ministry of Agriculture of the Republic of Croatia, the agriculture as an important economic sector has been getting less and less efficient for a number of years [RC 2012, 2013, 2014]. Such trend was caused by the shape and size, as well as cadastral
and legal status of cadastral plots of agricultural land [Ivković et al. 2010]. The Agricultural Land Agency (hereinafter: Agency) as one of the institutions involved in agriculture and as an integral part of the Ministry of Agriculture participated in the initiative on the basis of which the Croatian Parliament passed the Act on the Agricultural Land Consolidation in May 2015 [OG 51/2015, hereinafter: Act]. According to the Act, the consolidation of agricultural land is carried out for the purpose of consolidating the properties and cadastral plots into larger and more regular plots adequate for cost-effective use, of creating favorable conditions for the development of agricultural production, for the establishment and construction of field roads, water structures for land amelioration and execution of other works required to arrange the land intended for agriculture. Land consolidation is, in terms of the Act, a set of administrative and technical procedures applied to combine small and fragmented agricultural land into larger and better organized plots, to regulate road and duct networks and legal property issues, as well as other relationships attributed to the land.

According to the Act, the land consolidation can be initiated if:

- the land cannot be cultivated in a purposeful manner due to its fragmentation and irregular shape,
- it is not possible to organize such production that will justify the purpose of investments, due to significant land fragmentation or the existing legal property relations in the areas where water structures for amelioration have already been constructed or where they are under construction,
- the construction of new transport infrastructure (roads, railways) or other structures (dams, canals, etc.), as well as the regulation of large watercourses, will lead to further fragmentation of the existing cadastral plots and disruption of road and duct network.

If land consolidation is proposed because of the construction of water structures for land amelioration, land consolidation can be initiated if, among other conditions, the conditions for the construction of such systems, as specified by special laws, have been met as well. It was also found out that the land consolidation will not start if:

- it has been concluded that its implementation could worsen the conditions for agricultural production of land consolidation participants,
- the costs of land consolidation would not be in proportion to the benefits expected from it,
- without simultaneous land amelioration, no satisfactory results in agricultural production can be achieved,
- prescribed measures for protection of soil, biodiversity and landscape diversity are not provided.

3. Geodesy in land consolidation procedure – legal basis

An important part of the work in the implementation of land consolidation are professional geodetic tasks that can be performed by a person licensed to execute professional geodetic activities (hereinafter: licensed geodetic expert) in
accordance with a special law that regulates this area. The main professional geodetic activities in the process of land consolidation according to the Act are:

- staking out the boundaries of the land consolidation area,
- drawing up an agricultural roads network,
- staking out designed road and duct networks and consolidated cadastral plots in the field,
- participation in the presentation of the road network project and handling the objections to the project,
- development of maps of the land consolidation area and reports about the surfaces of the consolidated cadastral plots area,
- partial cadastral survey.

In addition to the above activities, the licensed geodetic expert:

- harmonizes cadastral and land registry records with the actual situation,
- participates in the land valuation and enters valuation results into the project report,
- draws up land status reports prior to land consolidation and takes part in their presentation, furthermore handles objections to such land reports,
- prepares a draft of the division of land consolidation mass,
- participates in a public discussion on the allotment of land parcels and in the process of the land consolidation participants entering into the possession of the allotted land,
- draws up land status reports after land consolidation, takes part in their presentation and handles objections thereto,
- draws up a draft decision on land consolidation according to the conclusions adopted in the discussion about land allocation, and the conclusions on submitted objections,
- draws up a consolidation project report (inventory of consolidated parcels, alphabetical list of land consolidation participants, draft disposition of the decision on land consolidation, valuation plans and technical report with overview maps about the status prior to and after land consolidation),
- provides information in administrative and judicial proceedings and disputes, when ordered to.

Pursuant to article 43, paragraph 3 of the Act, the director of the State Geodetic Administration passed the Ordinance on Expert Geodetic Works in Land Consolidation [OG 123/2015, hereinafter: Ordinance], which specifies the methods and the actions that licensed geodetic experts carry out for the purpose of accomplishing the land consolidation.

4. Initial activities

Article 4 of the Act specifies that the land consolidation is carried out on the basis of multi-annual and annual programs adopted by the Parliament and the Government of Republic of Croatia that are prepared by the Agency based
on expert analysis of the implementation processes of land consolidation. The first step in the preparation of the Agency’s program of land consolidation was to analyze the state of agricultural land on the Croatian territory by cadastral municipalities. Such analyses were made in collaboration with the Department for Spatial Information Management at the Faculty of Geodesy, University of Zagreb. The results showed a high level of fragmentation of agricultural land in all regions of the Republic of Croatia, so it was decided that the first locations to be taken will be the areas in various regions that are characterized by different geographical, agricultural, economic and social conditions. It was also decided that in these areas not only the land consolidation processes will take place with their first phase being the conceptual design, but they will also serve as an example for business processes in the above mentioned process. For these zero or pilot projects, the following land consolidation areas were selected:

- cadastral municipality Gundinci in the municipality Gundinci,
- cadastral municipalities Debelo Brdo and Jošanić in the municipality Udbina,
- cadastral municipalities Zdenci and Orahovica in the municipality of Veliki Zdenci,
- cadastral municipalities Ferketinec, Gornji Kraljevec, Podturen and Sivica in municipalities Vratišinec and Podturen
- cadastral municipalities Cerovlje and Novaki Pazinski in the municipality Cerovlje.

After the licensed geodetic experts had made the first analysis of the cadastral and land registry status of agricultural parcels and organized the first
gathering of owners, it was concluded that the land consolidation in the area of the municipality Cerovlje was not profitable because road and duct networks were already arranged there, and 95% of land was owned by the Republic of Croatia, hence, the best solution for the regulation of agricultural land was the preparation of geodetic project that would harmonize the state of the cadastral and land registry records with the actual situation [Figure 4.1].

5. Conceptual design – Phase I

The present studies of the Phase I of the conceptual design generally consist of several parts:

• description of the characteristics of the local administration, such as geographic characteristics, demographic data, information about settlements, economy, soil, climate, hydrography, canals (irrigation and drainage), existing roads and other,
• textual and numerical description of the cadastral municipality,
• a detailed analysis of the state of cadastral municipalities,
• analysis of the existing agricultural production (in collaboration with the agronomic experts),
• proposal of the final land consolidation area,
• proposal of required geodetic activities for the successful execution of the process of land consolidation,
• proposal of all activities to be executed in the process of land consolidation,
• estimate of the cost of land consolidation,
• explanation of economic justifiability of land consolidation.

The most important objectives of the Phase I of the conceptual design are to define the boundaries of the land consolidation area leading to the estimation of the type and scope of the activities, and thus the costs of the land consolidation procedures. It is further necessary to justify these economic costs, to familiarize the participants with the conceptual design of land consolidation and consequently obtain a decision on the procedure needed to start the land consolidation.

5.1. Defining the boundaries of the land consolidation area

In order to define the boundaries of the land consolidation area, licensed geodetic experts have collected all the information available: cadaster, land registry, LPIS layer (ARKOD parcels) owned by Paying Agency for Agriculture, Fisheries and Rural Development, the numerical data of the Croatian Forests, graphical data on mine suspected areas owned by Croatian Mine Action Centre, the graphics of the duct network and irrigation systems owned by Croatian Waters, and municipal and county spatial plans.

Based on these data, they have made a thorough analysis of cadastral plots according to the state of cadastral and land registry records, the analysis of
agricultural land-use, as well as the analysis of the existing road and duct networks, which has helped in defining the external border of the consolidation area. Municipal and county spatial plans have been taken to define the internal borders of the land consolidation area excluding building and other non-agricultural areas [Figure 5.1].

It is important to note that the analysis showed the necessity to conduct additional geodetic activities needed to define the boundaries of the land consolidation areas more precisely, as well as to use detailed field survey methods to obtain a better basis for designing road and duct networks.

![Figure 5.1 Land consolidation area in the cadastral municipality Ferketinec (produced by Geobiro d.o.o. Čakovec)](image)

5.2. Estimation of the type and scope of the activities

After defining the land consolidation area, the land consolidation mass has been precisely defined, as well as the cadastral plots to be included into the land consolidation procedure. By defining the land consolidation mass, all the types and scope of activities have been specified for the purpose of successful land consolidation. Some of these activities are: restoration of derelict land, renovation of existing and/or construction of new agricultural roads, renovation of existing and/or construction of new canals of main and detailed drainage and/or irrigation, and more. The bill of quantities for all the listed activities has been made and added to the costs of professional geodetic activities and other costs in order to obtain the final estimated cost of land consolidation. The estimated costs of land consolidation are certainly subject to changes because detailed cost estimates of
particular activities can be made only after additional geodetic activities are completed.

5.3. Explanation of economic justifiability of land consolidation

The economic justification of land consolidation is based on the comparison of the estimated cost of the entire land consolidation with the benefits achieved after the completion of the procedure. In order to demonstrate and prove the justification of land consolidation, the analyses were made from the agricultural point of view (increase in the total amount of agricultural land, forming parcels of optimal shape and size, the construction of drainage network – regulation of water regime), the economical point of view (construction of road network – lower costs, higher productivity, increased land value), and social point of view (greater influx of tax funds in the budget of local governments, increase of employment, regulation of property rights).

6. Predicted engineering activities

According to the Ordinance, the engineering activities carried out by licensed geodetic experts include the designing of the network of agricultural roads, designing and staking out the designed road and duct networks in the field, but there is certainly more to be noted like monitoring of land amelioration activities, especially the cultural-technical activities such as building of dams and embankments.

Only after the Agency has passed the decision about the initiation of the process of land consolidation and after the funds for land consolidation have been obtained, licensed geodetic experts can make a geodetic survey according to the requirements of the design that will allow the beginning of engineering activities. Horizontal and vertical accuracy of geodetic survey depends on the required accuracy requirements of the road or duct network project, and the same is made by the standard geodetic methods such as tacheometric or GNSS survey, and more recently by aerial remote sensing methods such as photogrammetric or LIDAR techniques.

When designing the road network, it is very important to consider the existing status of the road network and to try to achieve economic viability of their reconstruction or enlargement, as well as to coordinate the designing of the road network with the duct network design. It is necessary to pay special attention to the fact that these two linear features form regular parts of land consolidation mass (parent cadastral plots) that will be used for the formation of new cadastral plots for re-allocation and enable cost-effective agricultural production. Formation of new cadastral plots is a very challenging task in which it is necessary to agree on a few requirements:

- total value of land which land consolidation participant receives from the land consolidation mass cannot be less than 80% nor greater than 120% of land owned by that participant before start of the land consolidation.
• shape of cadastral plot must be suitable for agricultural production (regular shape, side ratio, plowing direction),
• respecting participants wishes concerning number, size and position of re-
   allocated cadastral plot without losing the purpose of land consolidation.

It is also important to allow only a few exits of agricultural machinery to
the main tar road in order to provide safe and smooth road traffic. The designing
process should meet the requirements specified in the Ordinance on Conditions
for the Design and Construction of Ports and Access to Public Roads [OG
95/2014].

According to the Article 13 of the Ordinance, the boundaries of road and
duct networks are staked out in such a way that the detail points of designed
pathways and canals are transmitted to the field by means of geodetic methods
specified in the regulations related to the state survey and real estate cadastre
and marked with visible permanent marks.

7. Improvement of legal basis

With completion of ongoing initial projects it will be possible to assess and
determine shortcomings of the current legal basis and create amendments to the
Act, as well as drafts of ordinances that will precisely prescribe works and
procedures defined by the Act.

Already after the completion of Phase I. of the conceptual design certain
shortcomings have been noticed, and some suggestions in terms of improving of
the legal basis were given:
• land consolidation area should be selected only if the consent of the
  majority of the land area owners has been given,
• starting land consolidation on the initiative of the owners of the majority
  of the land area owners in cooperation with geodetic firm and with the
  agreement of all relevant participants of the land consolidation,
• expanding land consolidation area on areas not intended for agricultural
  use by the spatial plan,
• purchase of private land in the land consolidation fund and sale of the
  same,
• production of the Ordinance on the assessment of land in the land
  consolidation.

8. Conclusion

According to the public opinion, the land consolidation of agricultural land
has been observed for many years as the method that could help in the
development of the Croatian agriculture. It is important to note that land
consolidation is not only the process of farm consolidation and of creating a new
network of canals and roads, but also an integrated process of creating favourable
conditions for the development of agricultural production, the increase of farmers
competitiveness, improving the physical conditions of each parcel, the rural
environment, and for creating the basic conditions for irrigation. Land consolidation improves the living and working conditions of farmers and other people in the village. Land consolidation encourages the changes in the agricultural sector and rural areas. Ultimately, it creates a transparent real estate market by creating new cadastre and land registry records.

The conceptual designs in four different locations in the Republic of Croatia clearly indicate that the land consolidation is indispensable, and its implementation is economically more than justified. Geodetic experts are the leaders in the process of land consolidation, and the engineering geodesy is of crucial importance in the initial phase because the designing of roads in conjunction with duct network greatly affects the final outcome of the land consolidation. It is necessary to restore the forgotten skills because there have been no land consolidation projects on the Croatian territory ever since it became independent, and it is obvious that it is necessary, and in the near future we can expect an increasing number of ongoing projects.

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Inženjerska geodezija u postupcima komasacije poljoprivrednog zemljišta u Republici Hrvatskoj


Ključne riječi: Agencija za poljoprivjedno zemljište, komasacija, melioracija, putna i kanalska mreža.

*scientific paper