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Modeling of reallocation in land consolidation with a hybrid method

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ABSTRACT

Land consolidation is one of the important tool of increasing productivity in agricultural production. Land consolidation not only consolidates fragmented land, but also improves the standards of landowners in agriculture, technical, social and cultural areas. Land consolidation projects consist of various stages. The most important, complicated and time-consuming part of these stages is land reallocation. Land reallocation is a process which requires a long time and high operating costs and in which there frequently arise disputes between landowners. For these reasons, it is inevitable to use computer technology to optimize this process. In this study, a hybrid method including genetic algorithm and fuzzy logic techniques which enable reallocation to be done automatically in land consolidation has been used. The crossover rate and the operation of the genetic algorithm (GA) method have been realized as a self-adaptive structure using fuzzy logic techniques. A similar study used for the land reallocation problem in the literature, the results of reallocation plans obtained by the technician and the results obtained by the hybrid method have been compared. When the experimental results are evaluated, it has been found that the hybrid method used is more successful and efficient than similar studies in the literature and also has a better reallocation plan.

1. Introduction

In recent years, agriculture has become an important sector for societies due to population growth. The hunger problem that is seen in some countries together with the population increase in the world today and that has the risk of emerging in other countries in the future makes the societies anxious. This situation makes it obligatory on one hand the implementation of new cropping aids in existing arable land and on the other hand increasing the production volume of agricultural products by opening the lands to production which are considered to be inefficient for today. Therefore, it has to be managed in a sustainable manner. Sustainable land management could be realized only with an effective land policy developed with long life planning. In Turkey, the majority of agricultural enterprises are not large enough, and the agricultural lands are too fragmented and cannot be processed efficiently. Disorders in agricultural structure due to fragmentation and clutter have a negative impact on yield and that also makes it difficult to take measures to increase yield and cause the costs to increase (Ekici and Sayılı, 2010).

Land fragmentation is caused by the separation of land belonging to an enterprise in rural areas into many different places and many pieces (Van Dijk, 2003). Land fragmentation is very common in developed countries (Latruffe and Piet, 2014). Land fragmentation reduces farm profitability (Di Falco et al., 2010). Land fragmentation is one of the most important problems for sustainable agriculture. Land consolidation is the most effective method to deal with this problem.

Land consolidation is one of the important means of increasing productivity in agricultural production. Land consolidation not only consolidates fragmented land, but also improves the standards of landowners in agriculture, technical, social and cultural areas (Pasakarnis and Maliene, 2010; Çay and Uyan, 2013; Uyan, 2016). In this respect, land consolidation not only improves agriculture but also contributes to the development of natural resources and rural development (Li et al., 2012). Land consolidation is practiced in many countries around the world.

Land consolidation projects consist of various stages. The most important, complicated and time-consuming part of these stages is land reallocation. Land reallocation is a process which requires a long time and high operating costs and in which there frequently arise disputes between landowners. The problem of land reallocation is the rearrangement of the land's current ownership structure in rural areas according to the country pursuant to land consolidation laws and existing practices (Demetriou et al., 2010).

Reallocation and creation of new parcels must be done in an equitable and fair manner in terms of enterprise owners. Otherwise, there will be constant objections to the project; farmer's gratitude will not be

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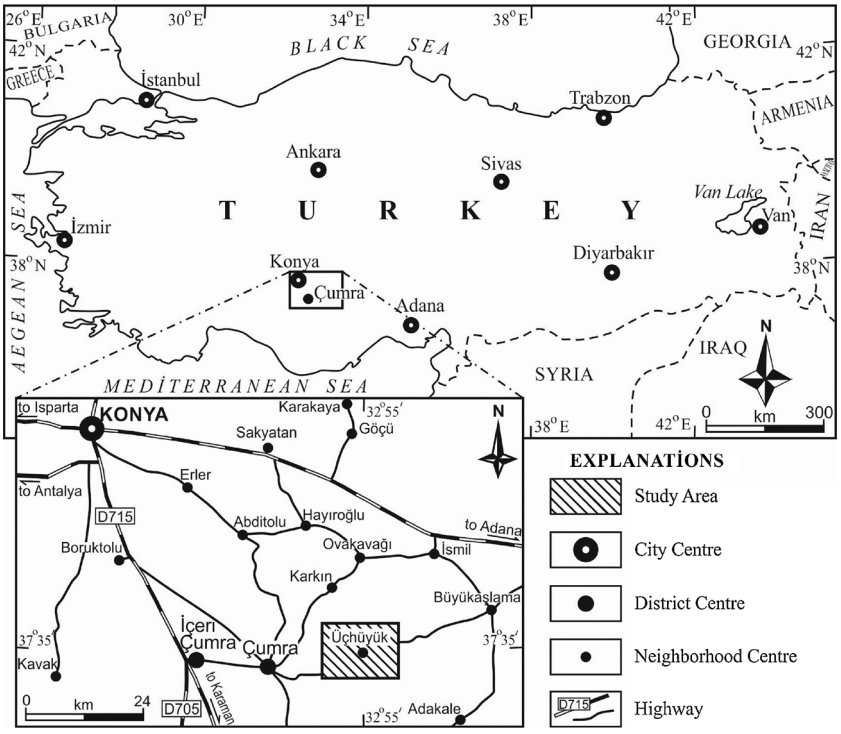

Fig. 1. Project area.

achieved and the project will not be accepted. In this respect, it can be said that the block reallocation is the most sensitive and careful stage of land consolidation (İnceyol, 2014).

Although the land consolidation work has been going on since the 1960s (Rosman and Sonnenberg 1998), a complete decision support system for land consolidation plans could not be achieved. Some previous studies have been undertaken with the idea of mathematical optimization for automatic reallocation (Avcı, 1999; Ayrancı, 2007). Although it is sometimes optimal in terms of the efficiency of results, it is not realistically or functionally applicable. Other studies have focused on the land partitioning (Buis and Vingerhoeds, 1996; Tourino et al., 2003).

Genetic algorithm (GA) is an optimization algorithm based on genetic and natural selection mechanisms (Goldberg, 1989; Emel and Taşkın, 2002). GA randomly tries to achieve a better solution in each iteration. For this, the existing solutions are applied to evolutionary GA operators (crossover, mutation) and at the end of each iteration, the survival of better individuals is ensured. While the randomness of the genetic algorithm allows the solution space to be scanned in different directions, the survival of the best individuals provides to reach optimal solution.

Fuzzy logic is to be defined as an artificial intelligence technique that works with uncertainties rather than certainty by using verbal variables. The difference of fuzzy logic from classical mathematical methods is that it does not work with certainty and it provides qualitative definition possibilities. Mathematical expression of ambiguities is considered the greatest convenience of fuzzy logic to the modeling of complex systems (Gülbağ, 2006).

There are areas where there are various disadvantages both for the GA and for the fuzzy logic method. In such cases, using these methods together with in a hybrid way can provide a solution. While the standard GA is more likely to be caught in the local optimum, Fuzzy Genetic Algorithm (FGA) spends more time finding the optimal solution. FGA automatically selects genetic operators or control parameters during evolution and this also eliminates the problem of early convergence and increases GA's success by improving its behavior.

In this study, a hybrid method is used which enables the reallocation to be done automatically in land consolidation. In this method, a hybrid system has been established by using the fuzzy logic method to determine the crossover ratio, which is one of the control parameters of the crossover technique and the genetic algorithm, which are the most important operators of the GA. The proposed method has been tested for the same application area using the codes of the program that was distributed according to GA previously done by İnceyol (2014). As a result, two different reallocations have been made for the same application area and the results have been compared. Since both methods automatically distribute the project according to the determined criteria, it is very important for land consolidation studies. The most important goal of the method that is created by using GA and hybrid method (FGA) is to shorten the project duration because the reallocation is done automatically. The purpose of comparing the two methods is to evaluate the hybrid method according to the standard GA and to find the best solution for the study area.

2. Material and method

2.1. Application area

The basic material of the study is the application area data of Üçhüyük Neighborhood of Çumra District in Konya City. The project was carried out by Directorate General of Agricultural Reform (TRGM) according to interview method pursuant to the provisions of Agricultural Reform Law Nr. 3083 on Land Regulation in Irrigation Areas on 20th October 2016. Block plans were prepared by TRGM. 17 blocks were created in the block planning. The location map of Üçhüyük Neighborhood, where terrestrial climate dominates, is shown in Fig. 1. Üçhüyük Neighborhood is 13 km away from Çumra and 63 km away from Konya.

Üçhüyük Neighborhood project area is 875.69 ha; there are 274 enterprises, 265 cadastral parcels and 17 blocks. Fig. 2 shows the cadastral situation map of Üçhüyük Neighborhood. The average size of the cadastral parcels is 3.30 ha.

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