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Research Article

Evaluation of the Beypınarı Land Consolidation Project of Erzurum Province in Terms of Quantitative Features

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Rural infrastructure,
Land fragmentation,
In-field services.

Abstract: This study was carried out to evaluate the efficiency of the Erzurum-Beypınarı land consolidation project. In the study, primary data were obtained from agricultural enterprises through a survey and secondary data from State Hydraulic Works. The minimum number of questionnaires was determined as 20, taking into account the finite population and a 10% safety margin. Quantitative data of the consolidation project were obtained with the help of the NetCAD program. According to the results obtained from the research, the consolidation rate in the research area was 67.9%. The average parcel size, which was 13.33 decares before consolidation, increased to 28.04 decares after consolidation. The water supply and water usage rates were 55.1% and 17.4%, respectively, between 2000-2012, and these values increased to 100% and 26.8% after consolidation. The ratio of shapeless parcels was 66.8% before Beypınarı consolidation, this value decreased to 15.4% after consolidation. With the consolidation, the length of the in-field road increased 2.67 times, and the rate of parcels directly connected to the road increased from 52% to 100%. Shareholders' sharing of agricultural lands before consolidation efforts resulted in the emergence of new businesses. However, the number of active agricultural enterprises has decreased. When agricultural active enterprises are considered, it has been observed that the number of parcels per enterprise, which was 16.11, decreased to 5.16 after consolidation. The fact that the Beypınarı project area borders the Erzurum Airport and the Kars-Erzincan ring road has transformed the agricultural lands into an attraction center, but made them disposed to misuse. From the research, it was concluded that land consolidation projects are beneficial in terms of quantitative features, but the multiplier effect can be increased by investigating them socially and economically.

Erzurum İli Beypınarı Arazi Toplulaştırma Projesinin Niceliksel Özellikler Açısından Değerlendirilmesi

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Anahtar Kelimeler

Sürdürülebilirlik,

Öz: Bu çalışma Erzurum-Beypınarı arazi toplulaştırma projesinin etkinliğini değerlendirmek için yapılmıştır. Çalışmada, birincil veriler tarım işletmelerinden anket yoluyla ve ikincil veriler Devlet Su İşleri'nden alınmıştır. En az anket sayısı, sonlu popülasyon ve % 10 güvenlik payı dikkate alınarak 20 olarak tespit edilmiştir. Toplulaştırma projesine ait niceliksel veriler NetCAD programı yardımı ile elde edilmiştir. Araştırmadan elde edilen sonuçlara göre araştırma alanında toplulaştırma oranı % 67.9 olarak gerçekleşmiştir. Toplulaştırma öncesinde 13.33 dekar olan ortalama parsel büyüklüğü toplulaştırma sonrasında 28.04 dekara yükselmiştir. Su sağlama ve su kullanma oranları 2000-2012 yılları

Kırsal gelişim,
Arazi toplulaştırma,
Kırsal altyapı,
Arazi parçalılığı,
Tarla içi geliştirme hizmetleri.

arasında sırasıyla % 55.1 ve % 17.4 olarak gerçekleşmiş olup, toplulaştırmadan sonra bu değerler % 100 ve % 26.8'e çıkmıştır. Beypınarı toplulaştırmasından önce şekilsiz parsellerin oranı % 66.8 iken, toplulaştırma sonrası bu değer % 15.4'e düşmüştür. Toplulaştırma ile birlikte tarla içi yol uzunluğu 2.67 kat artmış, doğrudan yola bağlı parsel oranı % 52'den % 100'e çıkmıştır. Toplulaştırma çalışmaları öncesinde hissedarların tarım arazilerini paylaşması yeni işletmelerin ortaya çıkmasına neden olmuştur. Ancak tarımsal aktif işletme sayısı azalmıştır. Tarımsal aktif işletme dikkate alındığında, 16.11 adet olan işletme başına düşen parsel sayısının toplulaştırma sonrası 5.16'ya düştüğü gözlenmiştir. Beypınarı proje alanının Erzurum Havaalanı ve Kars-Erzincan çevre yoluna sınır olması tarım arazilerini çekim merkezine dönüştürmüş, ancak amaç dışı kullanıma açık duruma getirmiştir. Kırsal göçün önlenememesi ise tarım arazilerinin etkin kullanılmamasına neden olmaktadır. Araştırmadan, arazi toplulaştırma projelerinin nicel özellikler açısından yararlı olduğu, ancak sosyal ve ekonomik yönden araştırılması ile çarpan etkisinin artırılabileceği sonucu çıkarılmıştır.

1. Introduction

Land consolidation is to join the farmlands to irrigation network and the road taking into consideration ecological requirements and combine the lands of the same enterprise that located in different directions and places compared to the village center, and in suitable shape geometrically in terms of agricultural processing (Arici and Akkaya Aslan, 2014). With land consolidation, parcels are rearranged and a positive parcel transformation is achieved. This situation facilitates the management of agricultural enterprises; it also directly affects the rural development processes. There are many studies on this subject in Turkey and the world. These studies are related to obtaining more efficiency from a unit area with land consolidation studies (Çelebi, 2010; Çakmak and Eminoğlu, 2013; Sönmezyıldız and Çakmak, 2013; Arslan and Değirmenci, 2016; Dağdelen et al., 2017), allowing the use of modern production techniques (Peker and Dağdelen, 2016; Değirmenci et al., 2017), making public and the other investments cheaper (Uçar and Kara, 2006; Kumbasaroğlu and Dağdemir, 2007; Akkaya et al., 2017; Asiama et al., 2018; Buday et al., 2018; Kirmikil and Aydus, 2018), and building social peace among the people who benefit from these services. (Demetriou et al., 2012; Kirmikil and Arici, 2013; Kosoe et al., 2020). In other words, these studies explain that land consolidation plays a major role in the effective and sustainable use of agricultural land.

Reducing the number of parcels per agricultural enterprise, increasing the average parcel area, ensuring that each parcel benefits from irrigation, drainage, and road network, ensuring effective use of irrigation water, and arranging the parcels in a manner suitable for mechanization are the quantitative objectives (visible, measurable) of land consolidation projects (Arici and Akkaya Aslan, 2014; Choumert, and Phelinas, 2015; Kuslu and Ertem, 2019). Although land consolidation efforts in Turkey have started about 60 years ago, this type of project is quite new in Erzurum province. It is aimed to assess Beypınarı Land Consolidation Project in terms of the acquisitions and changes quantitatively.

2. Materials and Methods

2.1. Study area

In Erzurum, the first compulsory consolidation decision was taken in the 13 village settlements in the Erzurum Plain within the Kuzgun Dam irrigation area with Cabinet Decree No. 7103 in 2004. Erzurum province Beypınarı rural settlement is also included in this scope (Figure 1). The consolidation project was started in 2010 and was completed at the end of 2012. Beypınarı is located between 39° 99′ north latitude and 41° 15′ east longitude, 9.5 km from Aziziye District and 16.1 km from Erzurum city center. Migration is experienced in a residential area. According to TURKSTAT (2020) data, the population of Beypınarı was 736 in 1965, 749 in 1975, 630 in 2000, and 417 as of the beginning of 2020. The altitude of Beypınarı is 1770 m and its total area is 16.416 km^2. In terms of soil properties, it is seen that it has I, II, and III grade farmlands with a depth of 90 cm alluvial and fine-textured soils (Canbolat et al., 1999). The average land slope varies between 0-2% and has a flat and nearly flat topography (Kuşlu and Yağanoğlu, 2007). The average of some meteorological data for long years

(1981-2018) in the study area is 5.2 °C for temperature, -1.8 °C for the lowest temperature, 12.2 °C for the highest temperature, and 404.9 mm for precipitation (TSMS, 2021).

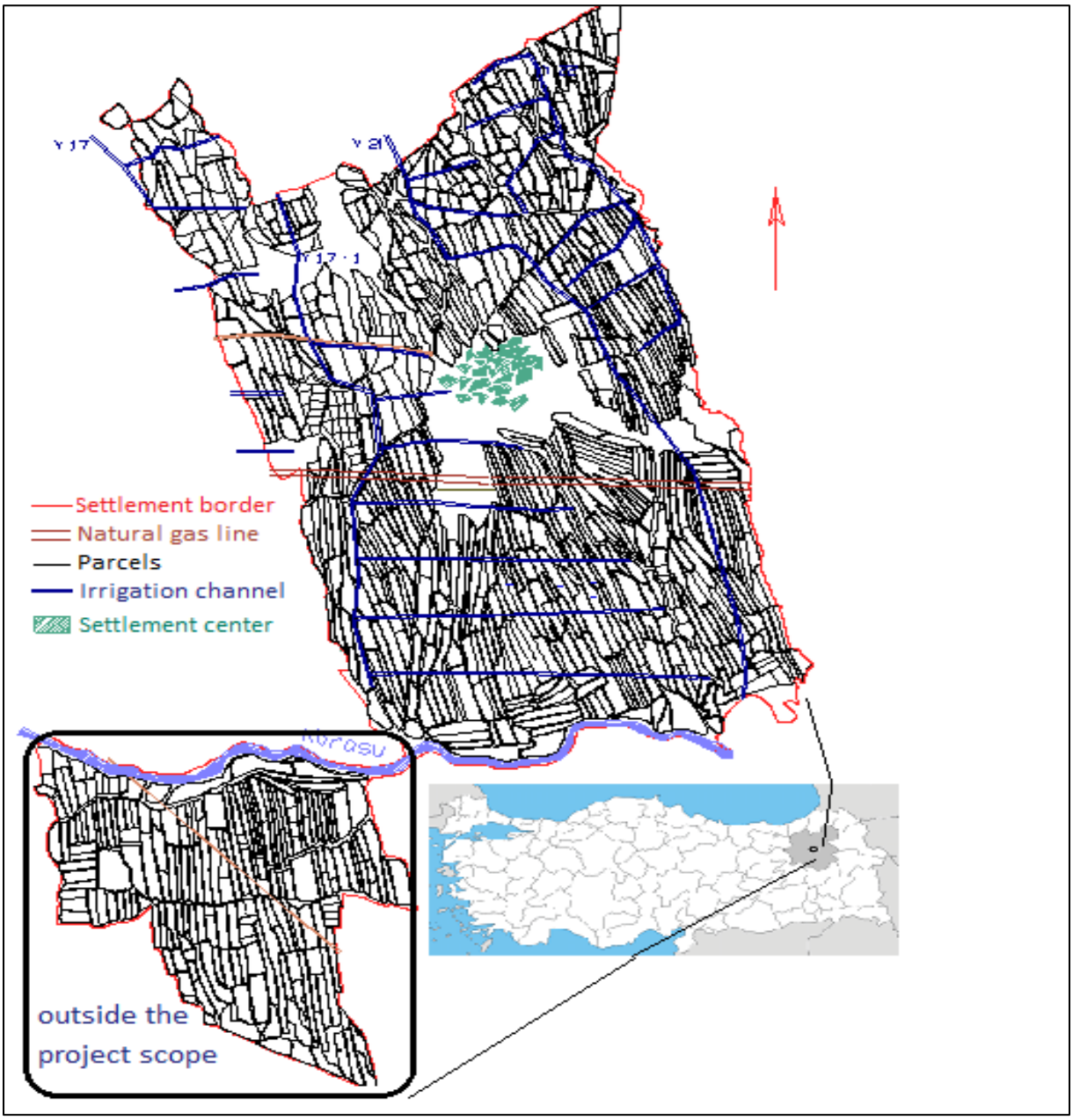

Figure1. Parcel status of Beypınarı before land consolidation (Kuslu, 2004).

2.2. Methods

Primary data on the research area were obtained from the questionnaires applied to the agricultural enterprises in the Beypınarı project area. While determining the minimum number of enterprises to conduct the study, the following equation developed for finite populations was used for the simple random sampling method, since the population subject to the study is finite and the variance is limited (Çiçek and Erkan, 1996):

$$n = \frac{N\sigma^2}{(N-1)D^2 + \sigma^2} \quad (1)$$

In the equation, n is sample unit number, N is population unit number, σ2 is population variance, and D is the possible error value. As a result of the calculations, 17 enterprises were found for the survey. Considering the data security margin, 20 enterprises were considered in the evaluation in the study.

The secondary data of the study were taken from the records of the VIII. Regional Directorate of State Hydraulic Works, Land Consolidation, and On-Farm Development Services Branch Directorate. The NetCAD program was used in drawing the maps.

In the study, the efficiency of Erzurum-Beypınarı consolidation was determined quantitatively by some criteria. These are number of enterprise rate (ENR), consolidation rate (LCR), parcel area change (PA), number of parcels per enterprise (NPE), water supply (WSR) and use (WUR) rates, road efficiency (RE), connecting road rate (CRR), and parcel shape criteria.

$$ENR = \frac{ENB}{ENA} x100 \quad (2)$$

$$LCR = \frac{PNB - PNA}{PNB} x100 \quad (3)$$

$$PA = \frac{PAB - PAA}{PAB} x100 \quad (4)$$

$$NPE = \frac{NPEB - NPEA}{NPEB} x100 \quad (5)$$

$$WSR = \frac{IL}{PrA} x100 \quad (6)$$

$$WUR = \frac{AICL}{IL} x100 \quad (7)$$

$$RE = \frac{RLB}{RLA} x100 \quad (8)$$

$$CRR = \frac{PCR}{PNA} x100 \quad (9)$$

In these equations, ENB; the number of enterprises before land consolidation (pcs), ENA; the number of enterprises after land consolidation (pcs), PNB; the number of parcels before land consolidation (pcs), PNA; the number of parcels after land consolidation (pcs), PAB; parcel area before land consolidation (da), PAA; parcel area after land consolidation (da), PrA; Project area (da), NPEB; the number of parcels per enterprise before land consolidation (pcs), NPEA; the number of parcels per enterprise after land consolidation (pcs), IL; irrigated land (da), AICL; active irrigated cultivated land (da), RLB; road length before land consolidation (km), RLA; road length after land consolidation (km), PCR; the number of parcels directly connected to the road (pcs).

One of the goals of land consolidation is to arrange the parcels in regular geometric shapes. In the research area, the parcels were grouped in three ways as quadrangular-shaped parcels with an acceptable aspect ratio (1/3-1/7), trapezoid-shaped parcels with at least two sides parallel to each other, and shapeless parcels, and the parcel shape was evaluated status before and after consolidation.

3. Results

The parcel status of the Beypınarı before and after the consolidation is given in Figure 1 and Figure 2.

Figure 2. Parceling status of Beypınarı after land consolidation.

The number of enterprises engaged in active agricultural activities in the Beypınarı settlement is 73, and the total number of enterprises registered in agricultural lands is 298. The LCR and NPE values for the Beypınarı project are given in Table 1. The number of parcels in the Beypınarı settlement, which was 1176 before consolidation, decreased to 377, and the consolidation rate was realized as 67.9%. The number of parcels per enterprise decreased both based on agricultural active enterprises and the basis of total enterprises.

Table 1. Land consolidation ratio (LCR) and number of parcels per enterprise (NPE) values for agricultural active and total enterprises

	PNB (pcs)	**LCR (%)**	**NPE***	**NPE****
Before land consolidation	1176	67.9	16.11	3.95
After land consolidation	377		5.16	1.27

* Enterprises currently engaged in agricultural activity, ** Including enterprises that do not reside in Beypınarı and do not engage in agricultural activities.

Information on the size distribution of the parcels and the change parcel area in the study area are given in Table 2. As can be seen from Table 2, the number of parcels according to their sizes is the highest in the I. group land class before and after consolidation. However, after consolidation, there was a decrease in small parcel groups (I. and II. groups) and an increase in other parcel groups. In all of the plots, there was an area increase of 110.35%.

Table 2. Parcel situation before and after land consolidation and average parcel size

	Number of parcel (pcs)				Rates (%)				Average parcel area (da)	PA (%)
Groups	I	II	III	IV	I	II	III	IV		
Before land consolidation	1016	135	16	9	86.4	11.4	1.4	0.8	13.33	110.35
After land consolidation	161	108	61	47	42.7	28.6	16.2	12.5	28.04	

I. group: <15 da, II. group: 16-30 da, III. group: 31-55 da, IV. group: >55 da.

The data obtained for water use (WPR, WUR) efficiency and indicators are given in Table 3. As can be shown from Table 3, the water supply rate has reached 100% with the consolidation project. While the water usage rate was 17.4% before consolidation, this value increased to 26.8% after consolidation.

Table 3. Water use indicators in the research area

	Before land consolidation (2000-2012 years) average	After land consolidation (2013-2019 years) average
Irrigated land (da)	8641.4	15672.7
Active irrigated cultivated land (da)	1505.4	4195.9
Project area(da)	15672.7	15672.7
WPR (%)	55.1	100
WUR (%)	17.4	26.8

The calculated indicators for the road network in the research area are shown in Table 4. The road length, which was 12801 km before consolidation, increased by 34235 km. With land consolidation, road efficiency (the proportion of parcels directly connected to the road) has risen from 52% to 100%.

Table 4. Beypınarı land consolidation project road network efficiency

	Road length (km)	Indicator	PCR	Number of total parcel (pcs)	RE (%)
Before land consolidation	12801	2.674	612	1176	52
After land consolidation	34235		377	377	100

The effect of the Beypınarı consolidation project on the parcel shape and the change that occurred is shown in Table 5. While the rate of shapeless parcels was 66.8% before land consolidation in the research area, this rate decreased to 14.0% after consolidation. The proportion of rectangular parcels increased from 15.4% to 69.0%.

Table 5. Parcel shape distribution of the Beypınarı

Shape group	Before land consolidation (pcs)	Rate (%)	After land consolidation (pcs)	Rate (%)
Quadrangular	181	15.4	260	69.0
Trapezoid	210	17.8	64	17.0
Shapeless	785	66.8	53	14.0

4. Discussion and Conclusion

Rural infrastructure defects such as increased fragmentation, fragmentation of parcels, road inadequacy, loss of time cause delays in planting time and prevent parcels from benefiting from infrastructure facilities (Latruffe and Piet, 2014; Yucer et al., 2016; Kuslu, 2019; Sardar et al., 2019; Ağızan et al., 2020; FAO, 2020; Kuzu and Değirmenci, 2020). At the end of all these, the desired product increase cannot be achieved. For the Beypınarı project, the number of enterprise change (ENR) values was determined as 87.13%. The ENR indicator should have been 100%. In the Beypınarı project, the reason why this ratio is below 100% has been investigated. The main reason for this situation is that the shareholders, who are not engaged in agriculture and do not reside in the Beypınarı, get their shares of lands in cadastral studies (Demirel and Şenol, 2019; Karakayacı, 2019). The fact that the project area borders the Erzurum Airport, which was put into service in 2005, and the Kars-Erzincan ring road are the most important factors. In this way, new enterprises have been created. The fact that the criterion is smaller than 100% indicates that new businesses are set up. Other indicators also need to be evaluated together with ENR.

The consolidation rate is the most known and widely used indicator of project success. As the consolidation rate increases, enterprises management becomes appropriate and the efficiency of land consolidation increases and the activity extends over time. The consolidation ratio of the study area has been calculated as 67.9% (Table 1). The average consolidation ratio in the land consolidation project in Turkey is 42.4% (Sönmezyıldız and Çakmak, 2018). The consolidation ratio of the Beypınarı project appears to be above the average of Turkey. In the enterprises whose main occupation is agriculture, the number of parcels per enterprise decreased from 16.11 to 5.16 after the project (Table 1).

Decreasing the number of parcels belonging to an enterprise increases the parcel size. As can be seen in Table 2, the average parcel size has increased from 13.33 decares to 28.04 decares with the consolidation project. The rate of change has been 110.35%. With the consolidation of Beypınarı, the share of the I. group lands (< 15 da) in total parcels, which was 86.4% before, decreased to 42.7%, while the other groups increased. This shows that consolidation is effective in reducing the number of small size parcels.

Beypınarı irrigation project was carried out with the irrigation of Kuzgun Dam (2002), but the consolidation project was completed at the end of 2012. Since the entire project area was opened to irrigation after the land consolidation project, the WSR value was 100% (Table 3). The water usage rate in the region was 19.63% on average between 2000 and 2019. The lowest water use rate was 13.8% in 2002, the highest water use rate was 33.15% in 2013, during the vegetation period after the completion of the consolidation project. But, the increase did not continue in the following years. The WUR values were realized as 28.3% in 2014, 24.53% in 2016, and 18.54% in 2019. If the irrigation rate is less than 30%, it indicates that the irrigation rate is "weak" (Çakmak and Eminoğlu, 2013). When the reasons for this are investigated, it has been determined that most of the Beypınarı lands are not cultivated, and the rural migration that previously existed has accelerated (Kuslu, 2009;). A similar situation is valid for other countries, and new approaches are needed for land consolidation studies (Akkaya et al., 2018; Büyüktaş et al., 2018; Muchova et al., 2018; Sardar et al., 2020).

One of the aims of land consolidation projects is to provide roads for all parcels. With the land consolidation project in the study area, it was ensured that all parcels benefit from the road network. The

indicator was found as 2.67 and the value greater than one indicates that the road activity is successful (Table 4).

The increase in the number of rectangular and square parcels is one of the indicators of effective consolidation. Before the Beypınarı consolidation, the ratio of quadrangular parcels was 15.4%, after consolidation, this rate increased to 69.0%. Considering that the effect of the parcel shapes on the mechanization tendency is a known fact, it can be concluded that the Beypınarı consolidation project is quite successful in this regard.

Beypınarı Land Consolidation Project has achieved most of its quantitative targets. As a result of the project, the total number of parcels and the number of parcels per enterprise has decreased. However, the average parcel area and the rate of utilization from irrigation drainage and road networks increased. A noticeable improvement in the geometric shapes of the parcels has been observed with the consolidation. However, the goal of increasing irrigation efficiency, one of the most important goals of land consolidation projects, has been insufficient. It has been concluded that the increase of this efficiency is not related to quantitative gains (increasing the irrigation-drainage network), but is closely related to the uncontrolled rural migration of the population engaged in agriculture in Beypınarı.

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