

# Evaluation of Aydın Koçarlı Plain Land Consolidation Project in Terms of Some Engineering Services

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**Abstract:** This study, which presents a general evaluation of the land consolidation project carried out in 14 settlements in the Koçarlı district of Aydın province, the 'Aydın Koçarlı Plain 1st Part Land Consolidation Project', completed by the Aydın Provincial Directorate of Agriculture in 2016, was examined. For this purpose, the consolidation rate, parcel reduction index, deduction rate, and changes in parcel size and parcel number values of the consolidation project carried out in Orhaniye, Madrandere, Çakırbeyli, Boydere, Cincin, Çakmar, Halilbeyli, Koçarlı, Büyükdere, Şahinciler, Sobuca, Dedeköy, Tekeli, and Gündürlü neighborhoods were investigated. In the project area, the average deduction rate was 7%, the consolidation rate was 31%, and the parcel reduction index was 1.46. As an overall evaluation of agricultural enterprises, the average parcel size increased from 1.76 ha to 2.57 ha, while the number of parcels decreased from 0.93 to 0.64. Land consolidation projects have a high potential to increase agricultural productivity and promote sustainable farming practices. Therefore, the results obtained from the study can contribute to the planning and implementation of similar projects.

**Keywords:** Agricultural land consolidation, consolidation rate, parcel reduction index

## Aydın Koçarlı Ovası Arazi Topluşturma Projesinin Bazı Mühendislik Hizmetleri Açısından Değerlendirilmesi

**Öz:** Aydın ili Koçarlı ilçesinde 14 yerleşim yerinde yürütülen arazi toplulaştırma projesinin genel bir değerlendirmesini sunan bu çalışmada, Aydın İl Tarım Müdürlüğü tarafından 2016 yılında tamamlanan 'Aydın Koçarlı Ovası 1. Kısım Arazi Topluşturma Projesi', incelenmiştir. Bu amaçla Orhaniye, Madrandere, Çakırbeyli, Boydere, Cincin, Çakmar, Halilbeyli, Koçarlı, Büyükdere, Şahinciler Sobuca, Dedeköy, Tekeli ve Gündürlü mahallelerinde yürütülen toplulaştırma projesine ait toplulaştırma oranı, parsel azalım indeksi, kesinti oranı, parsel büyüklüğü ve parsel sayısı değerlerindeki değişimler irdelenmiştir. Proje alanında ortalama kesinti oranı %7, toplulaştırma oranı %31 ve parsel azalım indeksi 1,46 olarak tespit edilmiştir. Tarım işletmelerine ilişkin genel bir değerlendirme yapıldığında, ortalama parsel büyüklüğü 1.76 ha'dan 2.57 ha'a yükselirken, parsel sayısı 0,93'ten 0,64'e gerilemiştir. Arazi toplulaştırma projelerinin tarımsal verimliliği artırma ve sürdürülebilir tarım uygulamalarını teşvik etme potansiyeli oldukça yüksektir. Bu nedenle çalışmadan elde edilen sonuçlar, benzer projelerin planlanması ve uygulanmasına katkı sağlayabilecek niteliktedir.

**Anahtar Kelimeler:** Tarımsal arazi toplulaştırması, toplulaştırma oranı, parsel azalım indeksi

## INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) stated that Turkey's total surface area is 78,535,000 hectares, and the total size of this area in terms of land assets is 76,963,000 hectares. According to 2014 estimates, 38,561,000 hectares of these lands are arable agricultural lands, and 11,612,600 hectares are forest lands (FAO, 2014; Tunali & Dağdelen, 2018). According to 2019 estimates, the value of arable agricultural land decreased by 845,000 ha to 37,716,000 ha. There was an approximately 2-fold increase in forest areas, reaching 22,064,360 ha (FAO, 2024).

As in many countries, abandoning agricultural lands, not processing them, and not renting them to other farmers are due to uneconomic agricultural practices in Turkey. This situation is mainly due to small enterprises not generating sufficient income and fragmented land structure (FAO, 2022).

According to Presidential Decree No. 30479, published in the Official Gazette on July 15, 2018, the responsibility and authority for land consolidation and on farm development services have been entrusted to the State Hydraulic Works

(DSİ) (DSİ, 2024). The most crucial advantage of DSİ's implementation of the projects is that land consolidation activities can be integrated with irrigation investments. Thus, it is estimated that water use efficiency will increase further in agriculture, which is the sector that uses the most water in the world, including Turkey. Table 1 shows the land consolidation projects carried out in Turkey over the years. When Table 1 is examined, it is seen that land consolidation projects continue to increase yearly. The fact that technology is used in the projects carried out by the General Directorate of Agricultural Reform and that the personnel working in this field gain expertise in consolidation projects is an essential factor in the increase in the number of projects carried out. After the transfer of the execution authority of these projects to the General Directorate of State Hydraulic Works, a much faster increase is observed.

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Table 1. Land Consolidation Studies in Turkey (DSİ, 2022)

YEAR	IMPLEMENTING ORGANIZATION	AREA (ha)
1961-2007	General Directorate of Rural Services - Special Provincial Administrations	582,000
2007-2018	General Directorate of Agricultural Reform - Provincial Directorates of Food, Agriculture and Livestock	3,018,021
2018-2023	General Directorate of State Hydraulic Works	3,673,566
<b>TOTAL</b>	-	<b>7,273,587</b>

Like many other countries worldwide, Turkey spends significant amounts of money, time, and effort yearly on land consolidation projects. In this way, it is ensured that the necessary infrastructure for agricultural land is provided, land fragmentation issues are minimized, agricultural land is improved, agricultural production is increased, socioeconomic development in rural areas is ensured, and rural landscapes are preserved. However, there is not enough emphasis placed on evaluating the success of land consolidation efforts (Akkaya Aslan, 2021). This study's primary purpose is to evaluate the land consolidation works completed in 2016 in 14 settlements in the Koçarlı district of Aydın province. Thus, it aims to create a resource for other regional projects.

#### MATERIALS AND METHODS

Aydın Koçarlı Plain 1st Part Land Consolidation Projects, which constitute the study material, started in 2007, and were completed in 2016. Within the project, in addition to the reallocation of parcels carried out within the land consolidation project in 14 settlement units located in an area of 6,500 ha, it is aimed that all parcels will have agricultural roads and benefit from the irrigation network. The decision of the Council of Ministers declared the application area on 23 March 2004 and published in the Official Gazette dated 22 April 2004.

The consolidation project in this area started on July 13, 2007. Within the scope of the study, Land Consolidation and On-Farm Development Services projects in Orhaniye, Madrandere, Çakırbeşli, Boydere, Cincin, Çakmar, Halilibeyli, Koçarlı, Büyükdere, Şahinciler, Sobuca, Dedeköy, Tekeli and Güdüşlü neighbourhoods were completed in 2016.

Koçarlı district, which is the project area, is located in the first sub-region of Aydın province, called Menderes Basin. Koçarlı district, one of the districts with the largest forest area within the borders of Aydın province, has fertile lands suitable for agriculture. The population distribution of the Koçarlı district between 2007 and 2022 is given in Figure 1.

When Figure 1 is examined, it is observed that there was a significant increase in population density between 2012 and 2013. This increase is due to Aydın Province becoming a metropolitan municipality in 2012. The district did not receive immigration, only village populations were added to the district population. According to the Master Plan prepared by the Aydın Provincial Directorate of the Ministry of Agriculture and Forestry of the Republic of Turkey in 2018, the population density of Koçarlı district, located in the 1st Sub-Region of the province, is 50 people/km<sup>2</sup>, and 138 people/km<sup>2</sup> throughout the province (Anonymous, 2018).

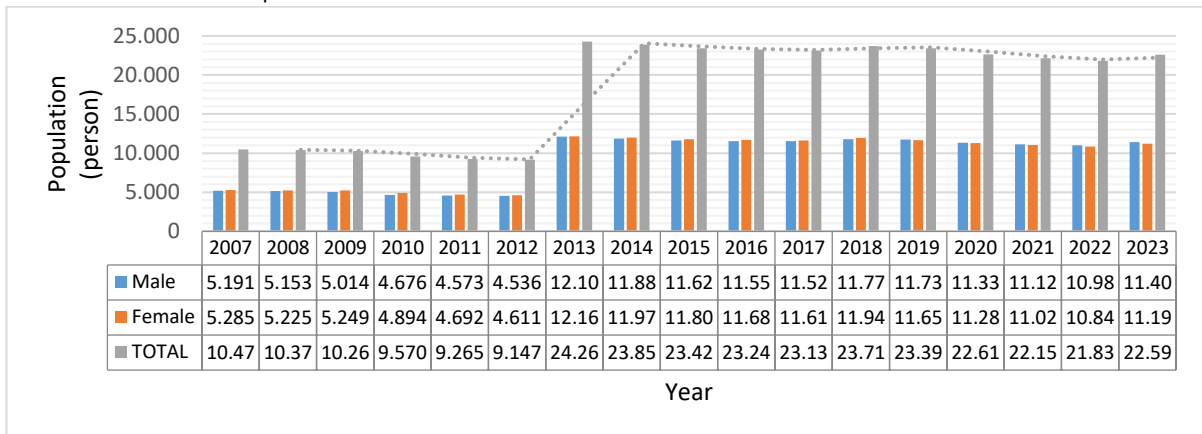


Figure 1. Population distribution of Koçarlı district between 2007-2023

In Aydın province, where maquis vegetation dominates, olives, figs, and chestnuts are abundant. The most forested areas in the province are in the Didim, Kuşadası, Efeler, Koçarlı, and Çine districts. Fig orchards in the Büyük Menderes basin start from the vicinity of Söke and continue to Aydın, Germencik, İncirliova, Köşk, Sultanhisar and Sarayköy. In the southern part of the region, Koçarlı,

Bağarası, Karacasu, Bozdoğan, Yenipazar, and Çine Plain are the places where fig trees are located. Among the most produced products in the Koçarlı district, melon, stone grapes, and stone pine are among the essential sources of income (Anonymous, 2018). The distribution of agricultural areas in Koçarlı district is given in Table 2.

Table 2. Koçarlı Plain Agricultural Areas

YEAR	PRODUCTION AREA (ha)					TOTAL
	Fruits, Beverage, and Spice Plants	Fallow	Vegetable	Ornament Plants	Crops and Other Plant Products	
2004	17,197	0	1,894	0	11,698	30,789
2005	17,694	25	2,027	0	11,733	31,479
2006	17,762	25	800	0	12,399	30,987
2007	17,418	0	1,145	0	12,238	30,800
2008	17,418	0	1,003	0	11,773	30,193
2009	17,418	140	1,002	0	12,610	31,170
2010	17,900	140	796	0	10,941	29,776
2011	17,900	140	796	0	9,249	28,085
2012	17,996	140	796	0	8,160	27,091
2013	18,339	146	1,388	0	10,232	30,106
2014	18,296	144	565	0	12,960	31,965
2015	18,296	149	565	0	11,981	30,990
2016	18,296	34	634	16	9,639	28,618
2017	16,995	24	446	16	10,940	28,421
2018	16,108	207	324	16	9,654	26,308
2019	14,731	21	419	16	9,694	24,880
2020	13,876	34	596	16	6,716	21,238
2021	13,926	75	419	16	9,506	23,942
2022	14,007	70	380	16	9,626	24,099
2023	14,064	110	368	16	9,535	24,093

When Table 2 is examined, it is seen that the production areas in the district have changed over the years. It is seen that most of the production area is devoted to fruit, beverage, and spice plants, followed by crops and other plant products. However, these values have changed over the years. For example, in the district where no ornamental plants were grown until 2010, ornamental plants were grown on an area of 160 decares by the end of 2023. Again, it has been observed that the share allocated to grains and other plant products has followed a decreasing trend since 2004 (TUIK, 2024).

The data used to carry out the study were taken from the Provincial Directorate of Agriculture records. The consolidation rate is the most crucial factor in determining the success of land consolidation projects. The definition of consolidation rate is based on the evaluation of land consolidation projects according to the number of parcels.

This ratio is the difference between the number of parcels before and after consolidation, expressed as a percentage compared to the number before consolidation. One of the most important indicators of the success of the project carried out in consolidation areas is the size of the consolidation rate. As the consolidation rate increases, enterprise management becomes more appropriate, and land consolidation projects' efficiency increases. In other words, input costs, such as labor, machinery, etc., per enterprise decrease as this ratio increases. In this study, average parcel size, number of parcels, and deduction rate values from parcels in the project area were examined in order to evaluate the project area. In addition, equations (1) and (2) were used to determine the consolidation rate and parcel reduction index (Arıcı, 1994; Crecente et al., 2002; Akkaya et al., 2007):

$$\text{Consolidation Rate} = \frac{\text{Pre consolidation parcel numbers} - \text{Post consolidation parcel numbers}}{\text{Pre consolidation parcel numbers}} \quad (1)$$

$$\text{Parcel Reduction Index} = \frac{\text{Pre consolidation parcel numbers}}{\text{Post consolidation parcel numbers}} \quad (2)$$

Finally, the situation of agricultural enterprises in the project area was examined. For this purpose, first of all, the average parcel size value per enterprise is obtained by dividing the size of the project area in decares by the number of parcels. The average number of parcels per enterprise was determined by dividing the number of parcels in the project area by the number of enterprises (Döner & Kaya, 2021).

Table 3. General information about the project area

Neighbourhood	Total Area (ha)	Number of Enterprises (pcs)	Deduction Rate (%)
Orhaniye	90.1	106	6.00
Madrandere	93.0	99	7.00
Çakırbeyli	631.5	355	6.00
Boydere	408.4	152	7.00
Cincin	382.7	330	6.00
Çakmar	306.5	141	8.00
Halilbeyli	589.8	425	6.00
Koçarlı	1110.2	397	6.00
Büyükdere	126.8	84	7.00
Şahinciler	143.7	84	6.00
Sobuca	319.1	241	6.00
Dedeköy	740.1	384	7.00
Tekeli	300.0	284	7.00
Güdüşlü	598.3	480	7.00
<b>TOTAL</b>	<b>5840.2</b>	<b>3562</b>	<b>7.00</b>

Among the neighborhoods included in the project, the largest area is the Koçarlı neighborhood. After that, the largest project area is in Dedeköy, Çakırbeyli and Güdüşlü neighborhoods, respectively. The Development Readjustment Share (DOP) deduction rate in the project area was 7% throughout the project area. A cut of 6 - 8% was made in all neighborhoods. The deduction rate in all neighborhoods in the project area is below 10%. It is preferred that there is no significant difference between the deduction rates made in settlements that are close to each other. This way, farmers will be made to think they are not being mistreated. This will positively affect farmer satisfaction, an essential criterion in evaluating land consolidation projects. In their study examining the Denizli Tavas Plain Consolidation Projects, Tunalı and Dağdelen (2018) reported that the deduction rate in 8 villages in the

## RESULTS AND DISCUSSION

Within the scope of Aydın Koçarlı Plain 1st Part Land Consolidation and On-Farm Development Services projects, the project area, number of enterprises, and the deducted area rates on a neighborhood basis for the 5840.2 ha part of the project area, which is 6500 ha in total, are given in Table 3.

project area varied between 2.20-5.50%, with an average of 4.02%. It is observed that the deduction rate is relatively high in this study compared to the literature. However, the project covers a significant part of the area allocated to the Irrigation Services, and Tourism Road works carried out by DSI and the General Directorate of Highways after the land consolidation and On Farm Development Services Projects in the district. In addition, it is thought that the closeness of the deductions made on a neighborhood basis also positively affects the project's success.

The project area consolidation rate and parcel reduction index values, which are among the most important criteria in evaluating the success of consolidation works, are given in Table 4.

Table 4. Consolidation rate and parcel reduction index values according to the number of parcels in the project area

Neighborhood	Pre-Consolidation Parcel Number (pcs)	Post Consolidation Parcel Number (pcs)	Consolidation Rate (%)	Parcel Reduction Index
Orhaniye	88	74	15.91	1.19
Madrandere	81	67	17.28	1.21
Çakırbeyli	258	216	16.28	1.19
Boydere	123	118	4.07	1.04
Cincin	277	210	24.19	1.32
Çakmar	85	75	11.76	1.13
Halilbeyli	467	273	41.54	1.71
Koçarlı	450	339	24.67	1.33
Büyükdere	103	58	43.69	1.78
Şahinciler	79	50	36.71	1.58
Sobuca	188	137	27.13	1.37
Dedeköy	442	249	43.67	1.78
Tekeli	244	167	31.56	1.46
Güdüşlü	425	237	44.24	1.79
<b>TOTAL</b>	<b>3310</b>	<b>2270</b>	<b>31.42</b>	<b>1.46</b>

When the consolidation rate and parcel reduction index values in Table 4 are examined, it is seen that Güdüşlü, Büyükdere, and Dedeköy neighborhoods, respectively, are above the Turkey average (Arıcı, 1994; Yağanoğlu vd., 2000). Considering other regional consolidation works, the project area's consolidation rate is somewhat low (Tunalı et al., 2016; Dağdelen et al., 2017). The project area's average parcel reduction index value was 1.46. When the parcel reduction index values reflect the technical quality/efficiency of the consolidation project, they show an increase in parallel with the consolidation rate. The lowest parcel reduction index values are 1.04 and 1.13 in Boydere

and Çakmar neighborhoods, respectively. The highest parcel reduction index values were in the Güdüşlü, Büyükdere, and Dedeköy neighborhoods, with 1.79, 1.78, and 1.78, respectively. In other studies conducted on this subject, parcel reduction index values were determined as 6.1 in Galicia (Spain) according to Crecente et al. (2002), 4.28 in Serem, and 1.51 in Beyköy according to Akkaya Aslan et al. (2007). According to Döner and Kaya (2021), it was found to be 0.99 in 16 villages in Bingöl Center.

In Table 5, the change in the average parcel areas of the project is given together with the increased rates.

Table 5. Change in average parcel sizes

Neighborhood	Pre-Consolidation Parcel Area (ha)	Post-Consolidation Parcel Area (ha)	Increase Rate (%)
Orhaniye	1.0	1.2	20
Madrandere	1.1	1.4	27
Çakırbeyli	2.4	2.9	21
Boydere	3.3	3.5	6
Cincin	1.4	1.8	29
Çakmar	3.6	4.1	14
Halilbeyli	1.3	2.2	69
Koçarlı	2.5	3.3	32
Büyükdere	1.2	2.2	83
Şahinciler	1.8	2.9	61
Sobuca	1.7	2.3	35
Dedeköy	1.7	3.0	76
Tekeli	1.2	1.8	50
Güdüşlü	1.4	2.5	79
<b>TOTAL</b>	<b>1.8</b>	<b>2.5</b>	<b>37</b>

The average parcel size value of the project area is 2.5 ha. According to Law No. 5403 dated 3/7/2005 on Soil Conservation and Land Use and Law No. 6537 on Amending the Law on Soil Conservation and Land Use (Official Gazette No. 29001 dated 5/5/2014), the minimum income irrigated agricultural land size for Koçarlı district is accepted as 5.0 ha

(Anonymous, 2024). Although the average parcel size of the project area is lower than the limit values specified in the Law, there has been a significant increase in parcel sizes in the entire area (Table 5).

The changes in the parcels belonging to the agricultural enterprises in the project area are examined in Table 6.

Table 6. Data on agricultural enterprises located in the project area

Neighborhood	Average Parcel Size per Enterprise (ha)		Average Number of Parcels per Enterprise (pcs)	
	Pre Consolidation	Post Consolidation	Pre Consolidation	Post Consolidation
Orhaniye	1.02	1.22	0.83	0.70
Madrandere	1.15	1.39	0.82	0.68
Çakırbeyli	2.45	2.92	0.73	0.61
Boydere	3.32	3.46	0.81	0.78
Cincin	1.38	1.82	0.84	0.64
Çakmar	3.61	4.09	0.60	0.53
Halilbeyli	1.26	2.16	1.10	0.64
Koçarlı	2.47	3.28	1.13	0.85
Büyükdere	1.23	2.19	1.23	0.69
Şahinciler	1.82	2.87	0.94	0.60
Sobuca	1.70	2.33	0.78	0.57
Dedeköy	1.67	2.97	1.15	0.65
Tekeli	1.23	1.80	0.86	0.59
Güdüşlü	1.41	2.52	0.89	0.49
<b>TOTAL</b>	<b>1.84</b>	<b>2.50</b>	<b>0.93</b>	<b>0.64</b>

From the results in Table 6, the average parcel size per enterprise in the project area increased from 1.84 ha to 2.50 ha. After completing the project, the highest and lowest average parcel size values per enterprise were seen in Çakmar and Orhaniye neighborhoods, respectively. However, when the proportional changes of these values are examined, the highest parcel size increase occurred in Güdüşlü neighborhood with 79%, and the lowest parcel size increase occurred in Boydere neighborhood with 4%. Again, when the number of parcels in the project area is evaluated, the average number of parcels per enterprise remains below 1. However, some change was observed before and after the project.

In addition to the Land Consolidation Project explained above, all parcels in the project area have been provided access to the irrigation and road networks. In this context, within the On Farm Development Services Project scope, the existing road network, which was planned to be increased to 331 km before the project started, was increased to 317 km. This difference is because the need for roads leading to the parcels during implementation is less than in the first project

draft. In addition, to solve the area's drainage problem, 59 km long main and 273 km long surface drainage channels were built. In order to eliminate problems related to irrigation, the damaged land surface in an area of 3000 ha was leveled to allow soil cultivation and irrigation. To solve the transportation problem, the increased road network was covered with stabilized material to bring it to a better quality state, and the parcel transportation network was completed by constructing 200 field crossings to connect the parcels to the road network (Anonymous, 2018).

#### **CONCLUSION**

Land consolidation is one of the most critical contributing cultural technical services in the planning of rural areas. For this reason it is given great importance in Turkey and worldwide. However, just completing these projects quickly is not enough. It is essential to evaluate the results of consolidation projects and to learn various lessons from these evaluations so that similar mistakes are not made in future projects. Following the COVID-19 pandemic that negatively affected the world, the Kahramanmaraş

Earthquakes experienced in Turkey last year caused adverse agricultural developments in many areas.

For this purpose, in this study, the land consolidation project completed in 2016 in the area covering 14 settlements in the Koçarlı plain was evaluated in general terms. The average consolidation rate in the project area was 31%, and the parcel reduction index was 1.46. This value was slightly below the Turkish average. However, when examined on a village basis, since the number of parcels per enterprise was not a very high value before the project, it becomes clear that the shareholding status of the lands should also be taken into consideration when examining the problem here. The projects should aim to reduce the amount of shared land.

One of the primary goals of consolidation projects is to provide irrigation and road networks to all parcels. This study showed that all parcels benefited from irrigation and road networks, which are one of the success indicators of the On-Farm Development Services Project. In this respect, it is possible to say that the project was concluded successfully in terms of On-Farm Development Services.

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