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Evaluation of the performance of irrigation associations in Antalya Region-Aksu Plain

Antalya Bölgesi-Aksu Ovası sulama birliklerinin performansının değerlendirilmesi

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ABSTRACT

When the performance of irrigation systems is made clear, irrigation water used in agriculture can be planned better and used more efficiently. Thus, water efficiency in irrigation can be at maximum level. It is the aim of this study to find out the irrigation intensity ratio (IIR), water use ratio (WUR), flow delivery ratio (FDR) and financial performances of five irrigation districts. In this study, the data which was gathered in 2014 from 5 irrigation districts in Aksu Plain, Antalya (Aksu-güney, Aksu-Karaöz, Aksu-Kuzey, Aksu-Orta and Aksu-Perge). IIR values were found to change between 0.81 and 0.98. The fact that IIR values are close to 1 reveals that the planning done prior to and during the irrigation season are close to one another. WUR values were found to change between 0.94 and 1.59. When WUR values are above 1, it can be suggested that more water than planned is given to the unit of area. Average FDR values were found to change between 0.92 and 1.33. The fact that FDR value is close to 1 reveals that water distribution is close to the planned or targeted rates.

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ÖZ

Sulama sistemlerinin performansının belirlenmesiyle, tarımda kullanılan suyun daha doğru bir şekilde planlanması sağlanabilecektir. Böylece su kullanım verimliliği en üst seviyelere çıkabilecektir. Bu araştırmada, beş adet sulama birliğinin sulama yoğunluk oranı (IIR), su kullanım oranı (WUR), akış dağıtım oranı (FDR) ile mali performanslarının belirlenmesi amaçlanmıştır. Araştırmada, Türkiye'nin güneyinde Antalya'da yer alan Aksu ovasındaki beş adet sulama birliğinin (Aksu-Güney, Aksu-Karaöz, Aksu-Kuzey, Aksu-Orta ve Aksu-Perge) 2014 yılı verileri kullanılmıştır. IIR değeri 0.81 ile 0.98 arasında değişim göstermiştir. IIR değerlerinin 1'e yakın olması sulama sezonu öncesi ve sulama sezonunda planlamaların birbirine yakın değerlerde olduğunu göstermektedir. WUR değerleri 0.94 ile 1.59 arasında değişmiştir. WUR değerinin 1'den büyük olduğu durumlarda birim alana verilmesi planlanan miktardan daha fazla suyun sevk edildiği söylenebilir. FDR ortalama değerleri ise 0.92 ile 1.33 arasında değişim göstermiştir. FDR değerinin 1'e yakın olması su dağıtımının planlanan yada hedeflenen oranda gerçekleştiğini ifade etmektedir.

1. Introduction

Irrigation district is one of the important components which organizes the distribution and consumption of irrigation water in agriculture (Özbek and Kaman 2015). The evaluation of irrigation districts has great significance for irrigation related administrators and planners to be able to increase efficiency of irrigation water consumption (Şener 2011). The distribution of irrigation water to farmers passed on irrigation districts and legal entities in 1990s from DSİ in Turkey. Thus, it was aimed to improve the performances of available water distribution systems and make them sustainable, decrease maintenance and administrative related expenses and use water resources more efficiently (Çakmak and Beyribey 2003). Irrigation districts are social organizations which attempt to ensure the appropriate use of irrigation water to be able to reach the planned targets of irrigation districts. System performance related evaluations need to be made at certain intervals to ensure the sustainable use of water resources and the effectiveness of organizations. (Ünal et al. 2004). Many researchers have been carried out in the literature to be able to evaluate the performances of different irrigation systems in different regions of the world (For example, Levine 1982; Garces 1983; Sampath 1988; Bird 1991; Akkuzu et al. 2003; Şener and Kurç 2012). In these studies which were carried out to evaluate the performances of irrigation systems, a lot of indicators have been developed

regarding the performance evaluation based on the purpose of use, irrigation system features and the characteristics of the region where the study was carried out. In the studies carried out in Turkey, the sets of indicators which were developed by Jurriens (1996) and Molden et al. (1998) were generally preferred. In the set of indicator which was developed by Jurriens (1996), water distribution performance of the irrigation system, water supply and variability in water supply were dealt with. (Akkuzu and Karataş 2004; Akkuzu et al. 2006). In the set of indicator which was developed by Molden et al. (1998), four different comparison methods were used regarding unit area and the yield compared to the water use (Çakmak 2001; Çakmak 2002). In addition to that, Şener (2011) used the sets of indicators developed by Levine (1982) and Perry (1996) to find out the supply ratio of water needs and the supply ratio of the irrigation water in Turkey. Except those mentioned above, İrtem and Sarı (2011) used correlation analysis method in measuring the efficiency of irrigation system in Balıkesir Plain between 2005 and 2009. To be able to benefit from the irrigation systems at maximum level, irrigation networks need to be monitored with the use of performance indicators fitting the purpose to be able to benefit from irrigation systems at maximum level (Kuşçu et al. 2009). For this purpose, this study aimed to evaluate the performances of 5 (Aksu-Karaöz (Hatipler), Aksu-Perge, Aksu-Kuzey, Aksu-Orta, Aksu-Güney) irrigation districts in Aksu Plain of Antalya province, which is located in the southern west of Turkey.

2. Materials and Methods

This study was carried out in Aksu Plain -Antalya Province, Turkey. The average temperature in the region where this study was carried out is 18.4ºC. Summers are hot and winters are cool and warm. The amount of average rainfall in the region is over 1000 mm (Yılmaz Kafalı 2008). The altitude of the region above the sea level in Aksu Plain is 18 m, and the region is densely cultivated (Climate-data.org 2015). It was planned in 1960 that 13394 ha area would be opened to cultivation (Karataban 1960). With the inclusion of more establishments in the region, the net irrigation area has reached up to 18700 hectares. There are five irrigation districts supplying irrigation water in the region. Relevant knowledge regarding the irrigation districts in the region is presented in Table 1 (DSI 2014a).

Table 1. Some knowledge regarding the irrigation districts in the region.

Irrigation District	The year opening for irrigation	The year of transfer	Gross area (ha)	Net irrigation area (ha)
Aksu-Güney	1962	1996	4100	3000
Aksu-Karaöz	1995	1999	3234	1720
Aksu-Kuzey	1962	1999	8203	4980
Aksu-Orta	1962	1995	3700	2000
Aksu-Perge	1962	1995	8645	7000

Some of the major products cultivated in the field of research are cotton, vegetable, greenhouse vegetable production, maize and citrus fruits (DSI 2014b). In the field of research, the delivery of irrigation water is mostly done through the open channel systems and gravity drainage. There are some regions where irrigation water is delivered to the irrigation lands through pumping systems in Aksu-Güney, Aksu-Kuzey and Aksu-Karaöz irrigation districts (Climate-data.org. 2005).

In this study, the following reports were used as the research material; irrigation water needs depending on planned plant pattern in the relevant irrigation districts in 2014 (DSI 2014c), planned and actualized irrigation water needs and the evaluation of water amount taken into the irrigation network (DSI 2014b), follow up and evaluation reports of 2014 regarding the transferred irrigation establishments (DSI 2014d), crop yield reports of 2014 (DSI 2014e). The data in the study was examined under two sub-titles as (1) water supply and water distribution performance and (2) financial performance.

Water supply and water distribution performance

The water supply performances of irrigation districts were determined under the light of water supply set suggested by Jurriens (1996) and water distribution uniformity was calculated accordingly. Irrigation Intensity Ration (IIR), flow delivery ratio (FDR) and water usage ratio (WUR) in water supply indicators were calculated with the help of the following equations (Jurriens 1996).

$$IIR = \frac{\text{Realized irrigation (area)}}{\text{Targeted irrigation (area)}} \quad (1)$$

$$FDR = \frac{\text{Diverted irrigation water amount}}{\text{The amount of irrigation water planned to divert}} \quad (2)$$

$$WUR = \frac{\text{Realized water consumption in the irrigated land}}{\text{The amount of water planned to be used in the irrigation area}} \quad (3)$$

In the evaluation of irrigation system performance, the degree of achievement in the irrigation planning of the irrigated area is expressed with any value close to 1. When IIR value is below 1, it means that the degree of achievement is low. Similarly, when the FDR value is 1, it means that the planned amount of irrigated water is diverted into the irrigation channels at the planned time. If it is above 1, it means that more than planned amount of water is diverted into water channels. The amount of water to be diverted used in the calculation of FDR is calculated by the irrigation associations taking into account the amount of declarations collected from the farmers and the amount of irrigation carried out in the previous years at the beginning of the irrigation season. When it is below 1, less than planned amount of irrigation water is diverted into the irrigation channels. WUR reveals the level of achievement in diverting the planned amount of water into the unit area. When WUR value is above 1, it means that the amount of water diverted into the unit area is more than needed. When it is below 1, it means that the amount of water diverted into the unit area is less than needed.

Financial Performance

The financial performances of irrigation districts were calculated with the use of performance indicators suggested International Irrigation and Drainage Technology and Research Program (IPTRID) and supported by FAO (Malano and Burton 2001). 3 indicators were used in the evaluation of financial performance. These indicators are these; the ratio of return on investment, the ratio of maintenance cost to the income and the performance of water rate collection. The following equations were used in the calculation of these indicators.

$$\text{The ratio of return on investment} = \frac{\text{Water rate collected from the water users}}{\text{Total operation and maintenance charges}} \quad (4)$$

$$\text{The ratio of maintenance cost to income} = \frac{\text{Maintenance cost}}{\text{Water rate collected from the users}} \quad (5)$$

$$\text{Performance of water rate collection} = \frac{\text{Water rate collected from users}}{\text{The amount of water rate collected}} \quad (6)$$

3. Results and Discussion

Water supply and distribution performance

Monthly values if the FDR investigated discussed all the water entering the system from the value planned in June, July and August for irrigation associations are seen to be less. FDR monthly values for these months range from 0.52 to 0.85. Months when the FDR value is below 1; More water should be transported to these areas and the yield should not be reduced due to water shortage in these areas. FDR monthly between 1.21 and 16.34 values for other months it is seen that change (Table 2). In cases where the monthly FDR value is greater than 1, more controlled water distribution is required. Water supply and distribution indicators are given in Table 3. It is seen that the values standing for IIR change between 0.81 and 0.98. The fact that IIR values are close to 1 indicates that the planning carried out prior to the irrigation season and during the irrigation season is close to one another. The highest IIR value (0.98) was calculated in Aksu-Perge irrigation district. Similarly, the irrigation districts of Aksu-Güney and Aksu-Orta were found to have accurately set their goals regarding the planned land size to be irrigated prior to the irrigation season with the IIR values of 0.90 and 0.93. In the irrigation districts of Aksu-Karaöz and Aksu-Kuzey, it was found that the size of land irrigated during the irrigation season was less than the planned size prior to the irrigation by 19% and 16% in turn.

Table 2. Monthly flow delivery ratio (FDR) values.

	FDR				
Months	Aksu Güney	Aksu Karaöz	Aksu Kuzey	Aksu Orta	Aksu Perge
March	0.00	0.00	0.00	0.00	0.00
April	4.47	15.81	16.34	7.70	3.34
May	1.64	1.74	1.99	2.03	1.22
June	0.66	0.70	0.85	0.68	0.52
July	0.69	0.63	0.76	0.66	0.53
August	0.66	0.73	0.83	0.72	0.57
September	1.21	1.25	1.63	1.51	1.32
October	6.24	5.13	2.65	8.80	6.08

WUR values were found to change between 0.94 and 1.59 (Table 3). When WUR values are above 1, it can be suggested that more water was delivered to the unit area than planned. The irrigation districts where more water use was actualized than planned are ranked as Aksu-Güney, Aksu-Orta, Aksu-Karaöz and Aksu-Kuzey. It was seen in Perge irrigation district that the actualized irrigation water was less than planned by 4%. In other words, the amount of water used in this irrigation district is less than the planned amount by 4%. The fact that FDR value is close to 1 means that water distribution is equal to the planned and aimed amount. When FDR average values are considered, it is seen that they change between 0.92 and 1.33 (Table 3). These values can be considered to be reasonable in Aksu-Perge (0.92), Aksu-Güney (1.11) and Aksu-Karaöz (1.15). However, when Aksu-Kuzey irrigation district is compared to the other irrigation districts, it is seen that FDR value is quite high (1.33). In other words, the amount of irrigation water to be diverted to Aksu-Kuzey irrigation district was exceeded by 33%. 8% less water was diverted in Aksu-Perge irrigation district. When the performances of irrigation water distribution in 1999 and 2000 in Menemen Sol Sahil Irrigation System were examined by Akkuzu et al. (2003), it was found that monthly FDR values of 1999 changed between 0.16-1.24, and the monthly FDR values of 2000 changed between 0.34 and 1. When the irrigation water distribution performances of Aşağı Gediz irrigation network was investigated by Akkuzu et al. (2006) regarding the data obtained between 2000 and 2004, it was found that seasonal FDR values changed between 0.55 and 1.48.

Table 3. Water supply and distribution indicators of irrigation districts.

Irrigation district	IIR	WUR	FDR
Aksu-Güney	0.90	1.23	1.11
Aksu-Karaöz	0.81	1.42	1.15
Aksu-Kuzey	0.84	1.59	1.33
Aksu-Orta	0.93	1.30	1.21
Aksu-Perge	0.98	0.94	0.92

Financial Performance

The details of financial indicators are given in Table 4. The ratio of return on investment was found to change between 0.59 and 1.51. In other words, it changed between 59% and 151%. Whereas the percentages between 60-75% were considered satisfactory, the percentages between 75-100% can be considered to be good. Aksu-Karaöz irrigation district was found to be the only district with the ratio of return on investment below 60% out of the irrigation districts investigated in this study. Aksu-Orta irrigation district was found to have the highest ratio of return on investment by 1.51. The average ratio of return on investment when considered all the districts, was found to be 0.90.

Table 4. Financial Performance indicators of irrigation districts.

	Aksu-Güney	Aksu-Karaöz	Aksu-Kuzey	Aksu-Orta	Aksu-Perge
The ratio of return on investment	0.88	0.59	0.71	1.51	0.83
The Ratio of Maintenance Cost to The Income	0.13	0.36	0.14	0.17	0.09
Water Rate Collection Performance.	0.75	0.52	0.70	0.94	0.59

The ratio of maintenance cost to the income was found to change between 0.09 and 0.36 (Table 4). The average ratio of maintenance cost to the income when all districts were considered was calculated as 0.17. When the water rate collection performances of the irrigation districts were examined, it was seen that they changed between 52-94%. The lowest water rate collection performance was found to be in Aksu-Karaöz by 52%. The average water rate collection performance for the irrigation districts in Aksu Plain was calculated as 70%. When the financial performance indicators were considered under the light of the data given here, the ratio of return on investment for Aksu-Güney, Aksu-Orta and Aksu-Perge irrigation districts can be suggested to be at reasonable level. The ratio of return on investment for Aksu-Karaöz irrigation district was found to be low, but it was found to be satisfactory for Aksu-Kuzey irrigation district.

In a study carried out by Şener and Kurç (2012), financial performances of 22 irrigation networks regarding the year of 2007 in Trakya region were investigated. It was found from the financial indicators that the ratio return investment, efficiency of water rate collection and maintenance cost to the income were found to change, in turn, 20-205%, 16-100%, 10-223% values. At the same time, the average ratio of return in investment for all the research areas was found to be 81%. It was also reported that the ratio or return on investment needed to be increased and more efforts needed to be made in water rate collection. In a study carried out by Çakmak and Beyribey

(2003), the system performances of the irrigation networks in Sakarya Basin regarding the years 1999-2000 were investigated. In this study, it was reported that the ratio of return on investment and water rate collection performances of the investigated irrigation networks changed between 54-941% and 21-111% values. The same researchers suggested that there was a need for the regulation of irrigation water pricing approaches within the basin to be able to increase the rate of collection.

4. Conclusion

IIR values reveal that there is a change in the planned irrigated area sizes prior to the irrigation season between 2-19%. This may have resulted from the fact that farmers may submit their declaration or make alterations in their declarations. More care should be given to the submission of declaration to be able to make better planning regarding the irrigation at the beginning of the irrigation season, and farmers should be encouraged to submit their declarations on time. Whereas seasonal flow distribution values indicate that the amount of irrigation water was delivered in the main water channels was more than planned, the monthly FDR values revealed that the amount of irrigation water distributed through the main water channel was not enough. It was found that all irrigation districts delivered less water than planned in June, July and August, but the amount of water delivered to the system in the months when water need was relatively less, was found to be more than planned. In these months; More water should be transported to these areas, where the yield should not be reduced due to water shortage. The WUR values for the irrigation associations discussed ranged from 0.94 to 1.59. If the WUR value is greater than 1, it can be said that more water is delivered to the unit area than the planned amount. Considering the plant pattern grown for the unit having WUR value greater than 1, it is suggested to make the water distribution by the rotation system. In addition, water distribution with closed pipe system can be proposed instead of water distribution with open channel.

The ratio or return on investment is the ratio to the expense, and it is an important financial indicator that needs to be considered by investors for the sustainability of the establishments. This indicator was found to be sufficient for all irrigation districts except Karaöz irrigation district. The ratio of maintenance cost to the investment was found to be below 25% except Karaöz irrigation district. It can be concluded that for those irrigation districts whose ratios of maintenance cost to the investment was below by 25%, there is no need for maintenance. However, it can also be concluded that sufficient budget was not allocated to maintenance. The water rate collection performance of the irrigation districts investigated in this study was found to change between 94% and 52%.

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