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Full Length Research Paper

Benchmarking performance assessment of irrigation water management in a river basin: Case study of the Susurluk river basin, Turkey

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Irrigation water management is facing organisational changes worldwide. At the beginning of the 1990s, Turkey started an accelerated transfer program in which management, operation and maintenance (MOM) responsibilities for the irrigation schemes were transferred to water users, who were mostly organized as irrigation association (IA). This study aims to benchmarking performance assessment of water users' organizations (WUOs) taken over irrigation water management in the Susurluk River Basin, Turkey. For this purpose, the indicators of water delivery, financial and productive efficiency were used. Averages of the organizations for the years between 2002 and 2007 calculated from the results ranged of 1878 to 10484 m^3 ha^{-1} for annual irrigation water delivery per unit command area (WDCA), 4633 to 16077 m^3 ha^{-1} for annual irrigation water delivery per unit irrigated area (WDIA), 0.75 to 1.45 for annual relative water supply,78 to 124% for cost recovery ratio, 78 to 257 \$ ha^{-1} for total MOM cost per unit area, 73 to 95% for water fee collection, 391 to 4377 \$ ha^{-1} for output per unit command area, 3348 to 5744 \$ ha^{-1} for output per unit irrigated area, 0.208 to 1.109 \$ m^{-3} for output per unit irrigation supply and 0.223 to 0.992 \$ m^{-3} for output per unit water consumed. The study results showed that the benchmarking indicators provided the WUOs in the basin to see where they were placed in comparison with others. As a result, performance assessment and benchmarking can help to improve performance of irrigation water management in a river basin.

Key words: Benchmarking, performance indicator, water management, organization.

INTRODUCTION

Recent decades have seen increasing emphasis on change as a critical driver of organizational success (Drucker, 1999; Ford and Gioia, 2000). Irrigated agriculture is facing organizational changes worldwide. There is a growing recognition worldwide that irrigation water management is a service provided to customers with better results when operated by decentralized organizations: this leads to irrigation management transfer (Zhovtonog et al., 2005). In 1993, Turkey started an accelerated transfer program in which MOM responsibilities for the irrigation schemes were transferred to farmers, who were mostly organized as 'irrigation associations' (IAs) (Svendsen and Nott, 2000). By 1996, 61% of the irrigated area (approximately 1 million ha) that had been managed by the General Directorate of the State Hydraulic Works (DSI, Devlet Su İşleri) was transferred and by 2005, over 94% of irrigated area was under the control of water users.

Irrigation and drainage sectors are faced with some problems like inefficient water use, poor operation and management of irrigation schemes, low returns etc. Irrigation performance assessment is an important management tool to aid in providing sound water service delivery. Performance assessment in irrigation and drainage can be defined as the systematic observation, documentation and interpretation of activities related to irrigated agriculture with the objective of continuous improvement (Molden et al., 2007). There is a clear relationship between performance assessment and organizational excellence. The latter can be defined as “organizational excellence an outstanding practice in managing organizations and delivering value for all stakeholders” (Moullin, 2007). Recently, academicians, practitioners and researchers have debated on development of new approaches, looking for better ways to measure and determine organizational performance more rapidly and reliably.

Performance indicators are a powerful tool for identifying deficiencies in irrigation district management (Rodriguez et al., 2008). A set of performance indicators was developed by the International Water Management Institute (IWMI) and likewise a new set of performance indicators called ‘‘benchmarking indicators’’ was developed by International Program Technology and Research in Irrigation and Drainage (IPTRID) to assess the performance of irrigation organizations (Molden et al., 1998; Burton et al., 2000; Malano et al., 2004).

Benchmarking can be defined as a systematic process for securing continual improvement through comparison, using indicators, with relevant and achievable internal and/external norms and standards. It can compare past and present performance, as well as the performance of (otherwise similar) entities, and/or compare a performance against a relevant set of 'best practices'. Benchmarking is a very powerful management tool widely accepted all over the world for analyzing and improving the performance of water resources projects (Cornish, 2005; Chivate, 2010). The benchmarking indicators cover a range of process service delivery, financial and environ-mental management. Also, the productive efficiency are essentially for comparison of scheme outputs against key inputs (land, water) and allow organizations to see where they are placed in comparison with others. The process indicators can then be used to investigate which processes are contributing well or poorly to this output relative to similar process on other schemes (Malano et al., 2004).

Performance assessment through key indicators has become a standard practice in the irrigation water management sector in many countries. The performance has been assessed for individual schemes, schemes in a basin or a region, and schemes at national level for specific types such as those public-operated and transferred to users’ organizations or cross–system comparison of irrigation systems all over the world. A few researchers have conducted studies to evaluate irrigation water management from the perspective of farmers (Naik and Kalro, 2000; Yercan, 2003; Ghosh et al., 2005; Kuşçu et al., 2009). On the other hand, most of resear-chers have conducted studies to assess the performance of irrigation management process using financial and physical indicators (Merdun, 2004, Yercan et al., 2004; Jayatillake, 2004; Diaz et al., 2004; Değirmenci et al., 2006; Yıldırım et al., 2007). Yazgan and Değirmenci (2002) assessed the performance of Bursa Groundwater Irrigation Scheme using several external indicators. Çakmak (2003) evaluated the performance of schemes located in the Kızılırmak Basin using several external indicators. Koç et al. (2006) and Koç (2007) evaluated the impact of the water users related to ma-nagement, operation and maintenance (MOM) services carried out by IAs in the Great Menderes Basin in Turkey. Dorsan et al. (2004) evaluated some physical, economic and institutional performance criteria of irrigation schemes, operated by Water User Associations (WUAs) in Lower Gediz Basin in Turkey. Similarly, Mengu and Akkuzu (2010) evaluated effects of the transfer of irrigation management in the Gediz Basin on water and land productivity and water supply. Akçay et al. (2006) assessed some of the economical, institutional and physical performance criteria of irrigation schemes in Menemen, Turkey. Çakmak et al. (2010) evaluated the irrigation system performance of transferred irrigation schemes in the DSI Fifth Regional Directorate service area in Turkey mainly for the year 2003 with the benchmarking indicators.

As a result, performance assessment has been the subject of much research. Most of the studies carried out are those that deal with operation, maintenance and finance, and assess the current situation of transferred irrigation system to WUOs. The effect of WUOs in a basin on the use of land and water resources has not been sufficiently addressed, and the question of how irrigated agriculture is performed with limited water and land resources has not been satisfactorily answered. However, the main aim and focus of this study is to draw attention to the effects of the management of WUOs in a basin on water supply, finance and water, and land productivity. Therefore, in this study, it was assessed and benchmarked in integrated perspective to water delivery, financial and production performance of WUOs in the Susurluk River Basin, which is one of the most important agricultural areas in the western part of Turkey.

METHODOLOGY

Study area

The Susurluk River Basin in the north west of Anatolian peninsula has long been an important centre for agricultural. The basin is between 40° 20′ in the North, 39° 10′ in the South, 29° 38′ in the east and 27° 20′ in the west. It has a total area of some 22399 km^2 and it is 2.88% of Turkey's acreage. The basin is surrounded by Sakarya Basin in the east, by the Sea of Marmara and its basin in the north, by Marmara and Aegean basins in the west and by Gediz Basin in the South (Figure 1). Susurluk Basin is an entire stream basin which occurred either by direct combination of Nilufer, Adranos (Kocasu), Emet, Simav (Susurluk), Murvetler and Madra (Kocacay) River in Karacabey district or by combination of them with outlets of Manyas and Ulubat Lakes. Adranos and Emet Rivers are the most important affluents of Susurluk River (Dorum et al., 2010). The total catchment runoff of this basin is approximately 5430 million cubic meters. The basin climate is temperate, sum-mers are hot and dry and winters are mild and rainy. The climate has been classified as moderate sub–humid with approximately a mean yearly rainfall of 650 mm, but rainfall amounts are extremely low in the summer period. There is limited rainfall during the irrigation season. Mean yearly temperature is approximately 15℃,

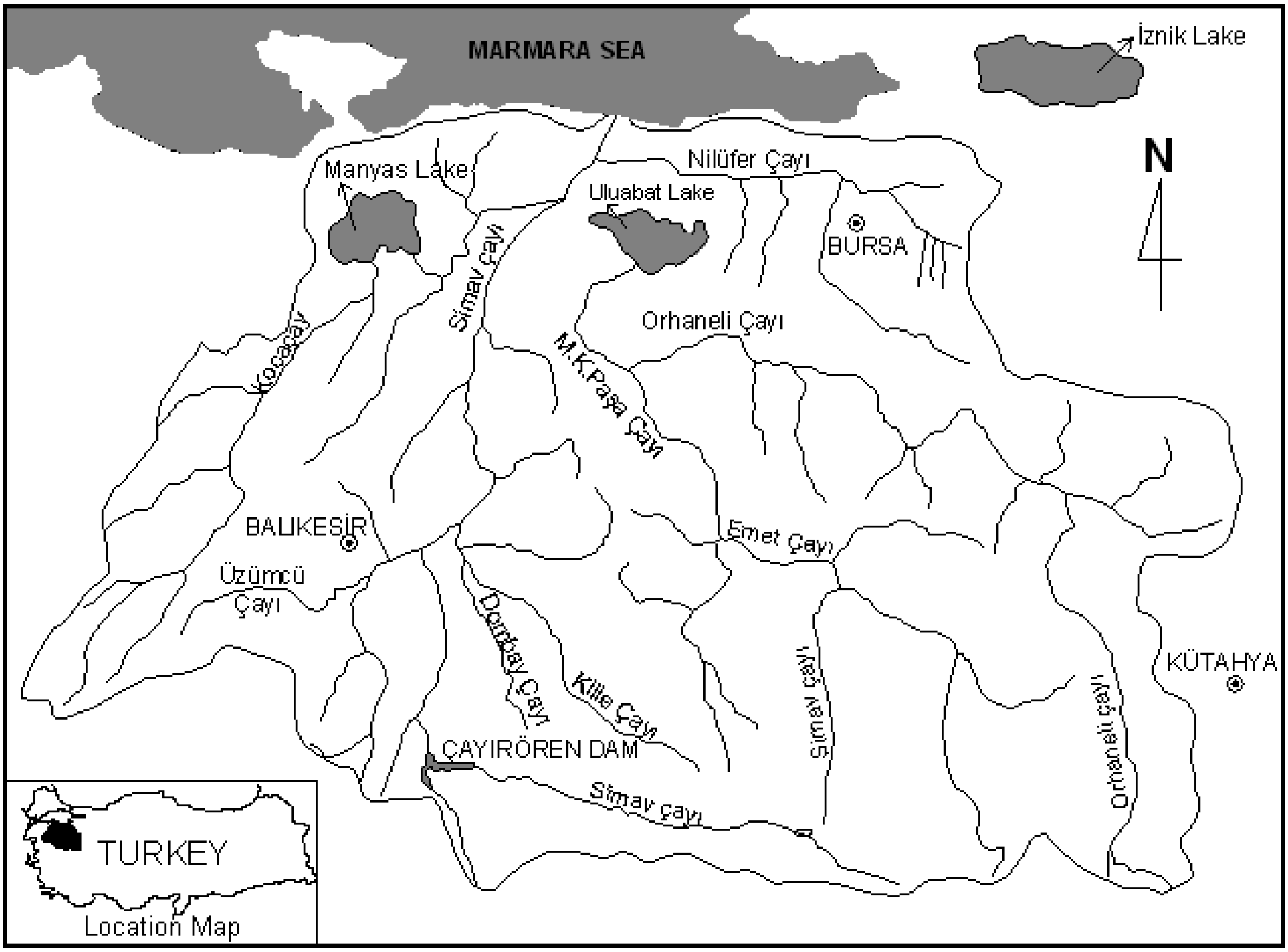

Figure 1. Susurluk river basin.

and the mean relative humidity is about 67%. Average amount of evaporation is 1054.9 mm. Vegetables and maize farming is the dominant agriculture in the Susurluk River Basin. In addition, sugar beet, fruits, tobacco and rice are also grown there. The average land-holding in the basin is about 2 ha.

Surface water for the basin is provided by one dam and twenty–three regulators serving 81695 ha. 98% of this area was transferred to IAs (75%) and other organizations (irrigation cooperative, association of service delivery to villages, municipality etc.). Also, farmers make use of groundwater by their own facilities.

Method

This study compares the performance of five WUO (one irrigation cooperative and four IAs) in the Susurluk River Basin. The organizations were selected for analysis because of their larger-than-average service areas in the basin. Also, they are amongst the earliest organizations taken over MOM responsibilities. Table 1 gives basic data on irrigation schemes operated by the WUOs.

In this study, water delivery, financial and productive efficiency performance indicators, proposed for benchmarking performance in the irrigation and drainage sector by IPTRID were used (Malano and Burton, 2001). Some of the recommended performance indicators were not considered due to irregular and unavailability of reliable data. The analysis is based on time series. Time series covering a period of 6 years (2002 to 2007) were collected to measure change in performance over time at the organization level. Data were obtained from those kept by the DSİ and the WUOs.

The performance indicators are presented as follows: American dollars were taken as the currency unit to facilitate comparison internationally. Water delivery performance indicators:

$$\text{Annual irrigation water delivery per unit command area } (m^3\ ha^{-1}) = \frac{\text{Total annual volume of irrigation water inflow}}{\text{Total command area serviced by the system}} \quad (1)$$

Table 1. Basic data of irrigation schemes selected for the study.

Characteristic	Name of irrigation scheme				
	Karacabey	Mustafakemalpaşa	Bursa YAS	Çavdarhisar	Sındırgı
Province	Bursa	Bursa	Bursa	Kütahya	Balıkesir
Year built	1989	1967	1988	1992	1970
Year transferred	1996	1997	1997	1997	1998
Nature of farmer organization	Irrigation association	Irrigation association	Irrigation cooperative	Irrigation association	Irrigation association
Command area (ha)	16683	16555	1650	4930	3798
Water source	River	River	Underground water	River	River
Turnout type of water	Regulator	Regulator	Water reservoir	Regulator	Dam
System type	Pomp	Gravity and pomp	Pomp	Gravity and pomp	Gravity and pomp
Conveyance and distribution network	Open canal	Open canal	Pipe under soil	Open canal	Open canal
Control structures	Manually operated gates	Manually operated gates	Manually operated plugs	Manually operated gates	Manually operated gates
Lowest water measurement point	Secondary canal	Secondarycanal	Hydrant	Secondary canal	Secondary canal
Main canal or pipe length (km)	43.1	59.9	11.4	50.7	51.3
Total canal length in scheme	373.1	505	-	220.2	123
Main crops	Maize, vegetables, leguminous	Maize, vegetables, feed crops	Fruits, vegetables, maize	Sugar beet, cereals, vegetables	Vegetables, maize, tobacco

$$\text{Annual irrigation water delivery per unit irrigated area } (\text{m}^3\ \text{ha}^{-1}) = \frac{\text{Total annual of irrigation water inflow}}{\text{Total annual irrigated crop area}} \quad (2)$$

$$\text{Annual relative water supply (no dimension)} = \frac{\text{Total annual volume of water supply}}{\text{Total annual volume of crop water demand}} \quad (3)$$

$$\text{Annual irrigation water delivery per unit irrigated area } (\text{m}^3\ \text{ha}^{-1}) = \frac{\text{Total annual of irrigation water inflow}}{\text{Total annual irrigated crop area}} \quad (4)$$

Financial performance indicators:

$$\text{Cost recovery ratio } (\%) = \frac{\text{Gross revenue collected}}{\text{Total management - operating - maintenance (MOM) cost}} \text{x100} \quad (5)$$

$$\text{Total MOM cost per unit area } (\$\ \text{ha}^{-1}) = \frac{\text{Total MOM cost}}{\text{Total irrigated area serviced by the system}} \quad (6)$$

$$\text{Water fee collection performance (\%)} = \frac{\text{Gross revenue collected}}{\text{Gross revenue invoiced}} \text{x}100 \quad (7)$$

Production performance indicators:

$$\text{Output per unit command area (\$ ha}^{-1}) = \frac{\text{Total annual value of agricultural production}}{\text{Total command area serviced by the system}} \quad (8)$$

$$\text{Output per unit irrigated area (\$ ha}^{-1}) = \frac{\text{Total annual value of agricultural production}}{\text{Total annual irrigated crop area}} \quad (9)$$

$$\text{Output per unit irrigation supply (\$ m}^{-3}) = \frac{\text{Total annual value of agricultural production}}{\text{Total annual volume of irrigation water inflow}} \quad (10)$$

$$\text{Output per unit water consumed (\$ m}^{-3}) = \frac{\text{Total annual value of agricultural production}}{\text{Total annual volume of water consumed by the crops}} \quad (11)$$

The total value of agricultural production received by producers is determined at local (domestic) market prices. For international comparison this value is converted into a common measure, the gross value of production (GVP), in which:

$$GVP = \Sigma[A_i Y_i P_i]MU \quad (12)$$

Where, *GVP*, gross value of production (US$); A_i, area planted to crop *I*; Y_i, yield of crop *I*; P_i, local prices of crop *I*; *MU*, currency exchange rate (US$/unit local currency).

RESULTS AND DISCUSSION

Water delivery performance

Water delivery performance over time for the five WUOs in the Susurluk River Basin is presented in Table 2. The annual irrigation WDCA varied between 1465 and 13086 m^3 ha^{-1} for the period 2002 to 2007. The highest and lowest values of WDCA were observed at the Sındırgı IA and Karacabey IA 13086 m^3 ha^{-1} in 2004 and 1465 m^3 ha^{-1} in 2007. The WDCA values were determined as 1465 to 5633, 3289 to 5287, 1527 to 5363, 1684 to 2008 and 5898 to 13086 m^3 ha^{-1} for Karacabey, Mustafakemalpaşa, Bursa YAS, Çavdarhisar and Sındırgı irrigation schemes, respectively. According to average results of six years, the highest and lowest WDCA value was obtained from the Sındırgı and Çavdarhisar irrigation schemes with 10484 and 1878 m^3 ha^{-1}, respectively (Figure 2). As Table 2 shows, the lowest value of WDCA for all irrigation schemes except Bursa YAS was 2007 year. In 2007, precipitations were significantly below normal recorded levels in the entire basin. The decline in total amount of water diverted to the irrigation schemes due to the drought might cause to low WDCA values. On the other hand, the Bursa YAS was not affected by drought, because its water resource is groundwater.

The annual irrigation water delivery per unit irrigated area (WDIA) provides a direct comparison with the estimated irrigation water requirements (Çakmak et al., 2004). The WDIA ranges between 2169 – 22098 m^3 ha^{-1} with Çavdarhisar irrigation having the highest as of 22098 m^3 ha^{-1} while Bursa YAS having the smallest as 2169 m^3 ha^{-1} (Table 2). According to average results, the highest and lowest WDIA value was obtained from the Çavdarhisar and Bursa YAS irrigation schemes with 16077 and 4633 m^3 ha^{-1}, respectively (Figure 2). In terms of gross figures for WDIA, Bursa YAS seems to be the best performer in overall. Also, Karacabey and Mustafakemalpaşa have relatively low gross figure of WDIA with of average 6770 and 7192 m^3 ha^{-1}, respectively.

Annual relative water supply (RWS) values varied between 0.37 and 1.97. As shown in Table 2, RWS in theirrigation schemes varied with the years and the highest RWS was obtained in Sındırgı irrigation scheme in 2004 with a value of 1.97 and the lowest rate was obtained in Karacabey irrigation scheme in 2007 with a value of 0.37. An RWS value of 1 or higher indicates adequate, and less than 1, indicates inadequately supply of irrigation. According to this general principle, average results of six years show that amount of water diverted to Mustafakemalpaşa, Çavdarhisar and Sındırgı irrigation schemes was adequate. On the other hand, amount of water diverted to Karacabey and Bursa YAS irrigation schemes was inadequate (Figure 2).

According to results of the indicators, the organizations with lower rate of success in water delivery can improve their performances by reviewing the successful organizations. In similar a study, Yıldırım et al. (2007) benchmarked and assessed the irrigation management transfer effects on irrigation performance in Turkey within

Table 2. Water delivery performance.

Organizations	Years	Irrigated area (ha)	Total of irrigation water inflow (×1000 m^3)	Irrigation water requirement (×1000 m^3)	WDCA[a] (m^3 ha^{-1})	WDIA[a] (m^3 ha^{-1})	RWS[a]
Karacabey IA	2002	9739	66480	78500	3985	6826	0.85
16683 ha	2003	10115	77150	100310	4624	7627	0.77
	2004	10763	78770	94630	4722	7319	0.83
	2005	11358	87040	104560	5217	7663	0.83
	2006	11750	93980	111050	5633	7998	0.85
	2007	7664	24440	66160	1465	3189	0.37
	Average	10232	71310	92535	4274	6770	0.75
Mustafakemalpaşa	2002	10066	65895	61869	3980	6546	1.07
IA	2003	10585	87527	78844	5287	8269	1.11
16555 ha	2004	10321	72451	66019	4376	7020	1.10
	2005	10696	83879	64543	5067	7842	1.30
	2006	11148	88019	79637	5317	7895	1.11
	2007	9760	54447	76860	3289	5579	0.71
	Average	10429	75370	71295	4553	7192	1.06
Bursa Irrigation	2002	1162	2520	4999	1527	2169	0.50
Cooperative	2003	1295	5265	6771	3191	4066	0.78
1650 ha	2004	1061	5245	5536	3179	4943	0.95
	2005	1219	5153	6173	3123	4227	0.83
	2006	1335	6781	6737	4110	5079	1.01
	2007	1210	8849	6146	5363	7313	1.44
	Average	1214	5636	6060	3415	4633	0.92
Çavdarhisar IA	2002	811	9300	8900	1886	11467	1.04
4930 ha	2003	610	8300	7600	1684	13607	1.09
	2004	564	9100	8600	1846	16135	1.06
	2005	448	9900	9300	2008	22098	1.06
	2006	550	9810	9230	1990	17836	1.06
	2007	596	9130	8230	1852	15316	1.11
	Average	597	9257	8643	1878	16077	1.07
Sındırgı	2002	3201	39400	30200	10374	12309	1.30
IA3798 ha	2003	2782	40800	26400	10742	14666	1.55

Table 2. Contd

2003	2782	40800	26400	10742	14666	1.55
2004	2721	49700	25200	13086	18265	1.97
2005	2950	46000	27700	12112	15593	1.66
2006	2940	40600	28400	10690	13810	1.43
2007	2812	22400	27500	5898	7966	0.81
Average	2901	39817	27567	10484	13768	1.45

[a] WDCA: Annual irrigation water delivery per unit command area; WDIA: annual irrigation water delivery per unit irrigated area; RWS: annual relative water supply.

the year 1995 to 2002. They determined the WDCA, WDIA and RWS values as 3547-6500 m^3 ha^{-1}, 10054 -13603 m^3 ha^{-1} and 2.33-3.49 for irrigation schemes managed by SHW and 6431-7933 m^3 ha^{-1}, 9127-11320 m^3 ha^{-1} and 2.05-2.45 respectively.

Comparing the water delivery performance indicators of this study area with the results of studies carried out by the researchers, it can be said to be good.

Financial performance

Temporal variations of the financial performance indicators for the period of 2002 to 2007 are shown in Table 3. The cost recovery ratio is a measure of the level to which revenue from irrigation services covers the MOM expenses from irrigation services. It may be most conveniently expressed as a percentage. The ratios were maximum in the Sındırgı IA with an average value of 124% and minimum in the Mustafakemalpaşa IA with an average value of 78% (Table 3). If the cost recovery ratio equals 100%, the operation as a whole is breaking even; if it exceeds 100%, then it is earning a surplus, while if it is below 100% the operation is losing money. In this case, average results shows that the Sındırgı IA and Çavdarhisar IA could financially sustain themselves for the MOM expenditures. Molden et al. (1998) reported values for 18 systems throughout the world ranging from 28 to 139%. Yercan et al. (2009) also calculated an annual average rates of 90% for water user associations and 87% for irrigation cooperatives in the Gediz River Basin.

The lowest MOM cost occurs on the Mustafakemalpaşa IA at an average of 78 \$ ha^{-1}, whilst the highest occurs on the Bursa irrigation cooperative with more than three times the figure at 257 \$ ha^{-1}. The costs per unit area may vary between the organizations because of differences at energy cost, type of irrigation system, built year, project area and management policy.

The values of water fee collection were maximum in the Sındırgı IA with an average value of 95% and minimum in the Mustafakemalpaşa IA with an average value of 73% (Table 3). The water fee collection performance is one of the most important financial performance indicators. Because, there is no other revenue of the WUOs, and also, it is necessary for the collection of water fees for financial self sufficiency. Nelson (2002) stated that this ratio should be close to 100%. A low value can indicate financial problems within the system, lack of support from the service provider, or a poor collection program. The collection rate was found to be average (85%) for the basin. This ratio shows that the cost of irrigation water was generally paid by farmers. The effectiveness of fee collection is related with adequacy, fairness and timeliness of water distribution regarding irrigation services given by the water users' organizations, water pricing policy and social and religious dimensions.

Water pricing is viewed as an economic instrument to improve water allocation and mitigate water scarcity situations (Bazza and Ahmad, 2002). Water fees are generally determined based on cultivated–area and cultivated-crop for the current year. This pricing policy is unsuitable from the perspectives of efficiency of water used and water conservation. This is because, there is no limitation to the quantity of water used.

In similar studies, water fee collection performance was calculated to be 82 to 98% and 70 to 89% for 13 IAs and 38 irrigation cooperatives in the Gediz River Basin over a 7-year period (from 1997 to 2003) by Yercan et al. (2009) with an average of 84% in the Menemen IA from 1995 to 2004 by Kukul et al. (2008).

In consideration of all the financial performance indicators, Sındırgı IA was among the most successful farmers' organization in the Susurluk River Basin. Other organizations in the basin can improve their own financial performance by taking

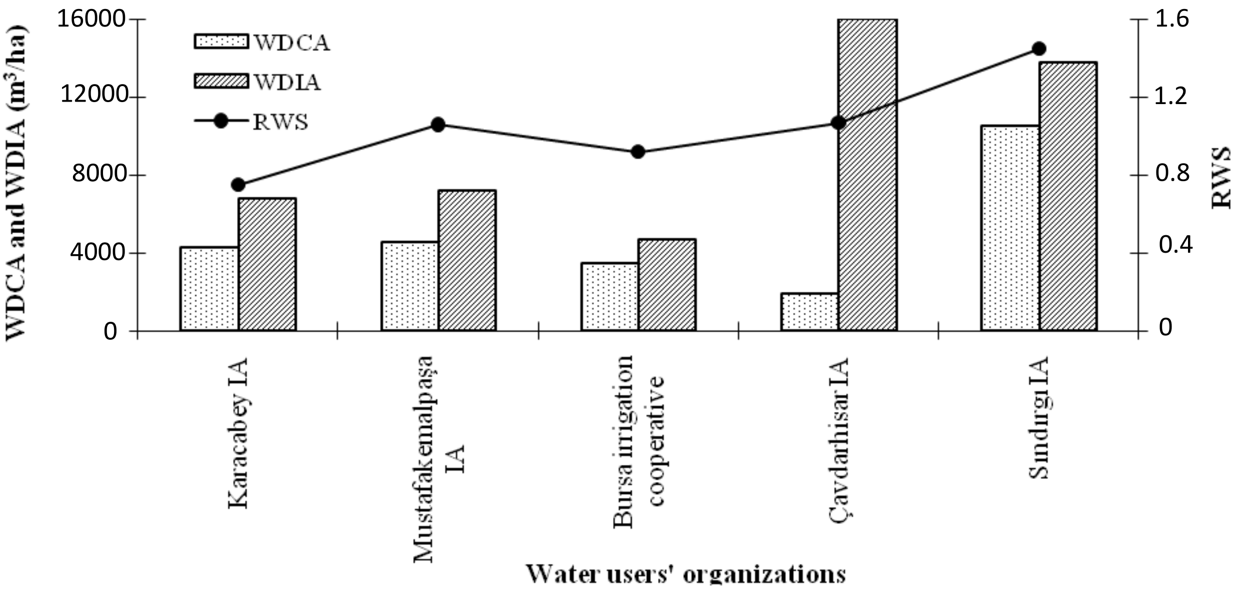

Figure 2. Average values of six years (2002 to 2007) period water of delivery performance indicators for the organizations.

into account the financial management of Sındırgı IA.

Production performance

Production performance indicators over time for the five farmers' organizations are presented in Table 4. Values of output per unit command of the irrigation schemes managed by the organizations varied between \$294 and \$6741 ha^{-1}. The 6 years of average results showed that the highest output per unit of command area was obtained from the Sındırgı irrigation scheme with average of \$4377 ha^{-1}, and the lowest from the Çavdarhisar irrigation scheme with average of \$391 ha^{-1} (Table 4). Cropping pattern and cropping intensity with large area and high yield and local price might lead to high output per unit command (Merdun, 2004). Vegetables, maize and tobacco farming are the dominant agriculture practiced in the Sındırgı while sugar beet, cereals and vegetables farming are the dominant agriculture practiced in the Çavdarhisar. Molden et al. (1998) stated that, systems including orchards, industrial crops and some cereals had high values of output per unit command. In addition, system type, climatic conditions and management type might indirectly affect these differences in output per unit command (Merdun, 2004). In similar studies, output per unit command values were calculated to be between \$105 to \$1800 ha^{-1} in the Alto-Rio Lerma project in Mexico and 2215 \$ ha^{-1} for SHW 10th Region irrigation schemes (Kloezen and Garces–Restrepo, 1998; Çakmak et al., 2004).

As shown in Table 4, values of output per unit irrigated area varied between \$2066 and \$8780 ha^{-1} for the period of 2002 to 2007. The highest and lowest values of the output per unit irrigated area were observed at the Karacabey and Mustafakemalpaşa irrigation schemes to be \$8780 ha^{-1} in 2007 and 2066 \$ ha^{-1} in 2002. However, according to average results of six years, highest and lowest values of the output per unit of irrigated area were obtained at the Sındırgı and Çavdarhisar irrigation schemes 5744 and 3348 ha^{-1} respectively. The output per unit irrigated area varied from one project to another due to fluctuations in the crop pattern and yields. In similar studies, values of output per unit irrigated area were found to be \$1223 to \$9436 ha^{-1} in 12 irrigation schemes in the Southeastern Anatolia Project (GAP) for the period of 1997 to 2001 by Değirmenci et al. (2003) and \$2900 to \$4000 ha^{-1} in 18 irrigation schemes in 1998 by Molden et al. (1998).

The highest and lowest values of output per unit irrigation supply were 2.753 \$ m^{-3} in 2007 and 0.175 \$ m^{-3} in 2003 in the Karacabey and Çavdarhisar irrigation schemes respectively (Table 4). In 2007, water diverted to the Karacabey, Mustafakemalpaşa and Sindirgi irrigation schemes was lower than crop water demand due to irrigation water scarcity (Table 2). Nevertheless, the highest value of output per unit irrigation supply was observed at the Karacabey irrigation scheme in 2007. The reason for this may be that, water users in the scheme make use of groundwater with their own facilities. In a similar study, output per unit irrigation supply was found to be \$0.10 to \$0.40 m^{-3} in the SHW 10th Region irrigation schemes by Çakmak et al. (2004) for the period of 1996 to 2000.

The output per unit water consumed in Table 4 shows variations of \$0.191 to \$1.262 m^{-3}. The highest (1.262 \$ m^{-3}) and the lowest (0.191 \$ m^{-3}) values were obtained

Table 3. Financial performance.

Organization	Year	Gross revenue collected ($)	Gross revenue invoiced ($)	Total MOM cost ($)	Cost recovery ratio (%)	Total MOM cost per unit area ($ ha^{-1})	Water fee collection performance (%)
Karacabey IA	2002	530625	728344	466213	114	48	73
	2003	851391	1139998	1354817	63	134	75
	2004	1162096	1458025	1842043	63	171	80
	2005	1673740	1920429	1523981	110	134	87
	2006	1788564	1788564	1624977	110	138	100
	2007	808151	808151	1590234	51	207	100
	Average	1135761	1307252	1400378	85	139	86
Mustafakemalpaşa IA	2002	296036	492650	447725	66	44	60
	2003	423429	722117	437567	97	41	59
	2004	543471	877131	744013	73	72	62
	2005	569161	1003542	861249	66	81	57
	2006	978640	999039	1006497	97	90	98
	2007	961338	961373	1377958	70	141	100
	Average	628679	842642	812502	78	78	73
Bursa Irrigation Cooperative	2002	166167	191024	127371	130	110	87
	2003	231917	279169	228481	102	176	83
	2004	223122	225258	274185	81	258	99
	2005	285133	348903	312566	91	256	82
	2006	322517	378499	363216	89	272	85
	2007	409281	460376	566151	72	467	89
	Average	273023	313871	311995	94	257	87
Çavdarhisar IA	2002	63318	78420	59171	107	73	81
	2003	69070	83949	66230	104	109	82
	2004	76121	91369	74223	103	132	83
	2005	91171	102838	92723	98	207	89
	2006	101482	109795	100021	101	182	92
	2007	119827	135560	126931	94	213	88
	Average	86831	100322	86550	101	152	86
Sındırgı IA	2002	171852	172161	197445	87	62	100
	2003	306356	328159	253354	121	91	93
	2004	471705	509519	288410	164	106	93

Table 3. Contd.

	2003	306356	328159	253354	121	91	93
	2004	471705	509519	288410	164	106	93
	2005	542165	598492	529379	102	179	91
	2006	705103	710349	482800	146	164	99
	2007	738595	782860	624772	118	222	94
	Average	489296	516923	396027	124	137	95

Table 4. Production performance

Organizations	Years	Output per unit command area ($ ha^{-1})	Output per unit irrigated area ($ ha^{-1})	Output per unit irrigation supply ($ m^{-3})	Output per unit water consumed ($ m^{-3})
Karacabey IA	2002	1293	2215	0.325	0.275
	2003	1603	2643	0.347	0.267
	2004	2956	4583	0.626	0.521
	2005	3512	5158	0.673	0.560
	2006	5096	7236	0.905	0.766
	2007	4033	8780	2.753	1.017
	Average	3082	5102	0.938	0.568
Mustafakemalpaşa IA	2002	1256	2066	0.316	0.336
	2003	1536	2402	0.290	0.322
	2004	3707	5946	0.847	0.930
	2005	2829	4378	0.558	0.726
	2006	3093	4593	0.582	0.643
	2007	3432	5821	1.043	0.739
	Average	2642	4201	0.606	0.616
Bursa Irrigation Cooperative	2002	1826	2592	1.195	0.603
	2003	2760	3516	0.865	0.673
	2004	4234	6585	1.332	1.262
	2005	4231	5728	1.355	1.131
	2006	4360	5389	1.061	1.068
	2007	4531	6179	0.845	1.216
	Average	3657	4998	1.109	0.992

Table 4. Contd.

Çavdarhisar IA	2002	366	2226	0.194	0.203
	2003	294	2380	0.175	0.191
	2004	447	3911	0.242	0.256
	2005	381	4188	0.189	0.202
	2006	440	3947	0.221	0.235
	2007	416	3439	0.225	0.249
	Average	391	3348	0.208	0.223
Sındırgı IA	2002	2849	3380	0.275	0.358
	2003	2461	3360	0.229	0.354
	2004	2845	3972	0.217	0.429
	2005	4912	6325	0.406	0.674
	2006	6741	8709	0.631	0.902
	2007	6455	8718	1.094	0.891
	Average	4377	5744	0.475	0.601

in Bursa YAS in 2004, and in Çavdarhisar in 2003, respectively. The difference depends on cropping patterns and the abilities of farmers and system managers (Değirmenci et al., 2003). The output per unit water consumed was determined to be \$0.050 to \$9.750 m^{-3} by Çakmak (2003) in the Kızılırmak Basin irrigation schemes for the period of 1996 to 2000.

Conclusions

The benchmarking indicators are suitable for the comparison of irrigation management performance among WUOs in a basin. The objective of this study was to apply the benchmarking performance indicators developed by the IPTRID to 5 WUOs taken over the MOM responsibilities in the Susurluk River Basin and to evaluate the management interventions.

A common practice in irrigation supply is to apply water to the root at the required time, amount and quality. In this study, the average relative water supply, as an important water use efficiency indicator, varied between 0.75 and 1.45 for the organizations in the basin. This result indicates that water for irrigation was at ideal levels in all the organizations except Karacabey IA. Results of the other water use efficiency indicators were satisfactory for the Susurluk River Basin.

Water fee collection rates were generally good on the all organizations in the basin. The collection rate was found to be average (85%) for the basin. This ratio shows that the cost of irrigation water was generally paid by farmers with reference to satisfaction with the irrigation water service delivery. In general, Sındırgı IA was of the most successful farmers' organization in the basin in terms of financial performance. This organization can be used as benchmarks against which the other irrigation organizations can assess their financial performance.

The analysis showed that the organizations except Çavdarhisar IA performed well, with one scheme, Sındırgı, that performed averagely better than the others in terms of production per unit of command and irrigated area and another organization; Bursa Irrigation Cooperative, also performed averagely better than the others in terms of production per unit of water supplied and consumed. The variability in output per unit land and water might be due to variations in crop pattern and intensity in addition to the diverted water supply.

This study provides support for literature claiming that performance of irrigation water management should be assessed in the light of integrated approach. Analyses in this study show the bench-marking performance of WUOs in a basin may be lead to searching for best practices, regenerative ideas and highly effective operating procedures considering the experience of others.

As a result,performance assessment and benchmarking can help to improve the water delivery, financial and production performance in a river basin.

Nomenclature: ***GVP***, gross value of production (US$); ***$A_i$*,** area planted to crop *I*; ***Y_i*,** yield of crop *I*; ***P_i*,** local prices of crop *I*; ***MU*,** currency exchange rate (US$/unit local currency); **WDCA,** annual irrigation water delivery per unit command area (m^3 ha^{-1}); **WDIA,** annual irrigation water delivery per unit irrigated area (m^3 ha^{-1}); **WUO,** Water Users' Organization; **RWS,** annual relative water supply; **MOM,** total management-operation-maintenance cost; **SHW,** State Hydraulic Works; **IA,** Irrigation Association; **IWMI,** International Water Management Institute; **DSİ,** General Directorate of the State Hydraulic Works.

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