AgroLife Scientific Journal - Volume 2, Number 1, 2013
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

EVALUATION OF DEVEGECIDI IRRIGATION SCHEME ON THE IRRIGATION MANAGEMENT IN SOUTHEASTERN ANATOLIA REGION OF TURKEY

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Abstract

Some of the irrigation schemes in Turkey have three main problems in terms of irrigation management and operation. These are (a) inequality on water distribution to the farmers, (b) no obtaining the appropriate benefits from the irrigation projects or irrigation schemes since the inadequacy on irrigation management and (c) insufficient on maintenance of the irrigation schemes. The irrigation schemes in Turkey were operated by the government sector (DSI, State Hydraulic Works) up to 1994. After then, DSI has transferred the irrigation schemes to the Water User Associations (WUA). Devegeçidi Irrigation Scheme located in Southeastern Anatolia Region of Turkey receives irrigation water from Devegecidi Dam. Total project area is 10044 ha however 6900 ha of this area is planned to irrigate. On the other hand, although cotton was planned as 13%, the realized rate of cotton area was ranged from 12% through 97% according to the years. The mainly cultivated crops are cotton, cereals and vegetables. The capacity of the main conveyor canal is 9 m^3/s. The practically irrigated area was ranged from 4250 ha through 5800 ha depending on years. Some farmers do not irrigate the fields because of fallow and the lack of maintenance on irrigation schemes. Some farmers can not get the water because the fields are the far to the irrigation schemes or water can not be reached to the end of the scheme. In addition the over irrigation is another problem. The irrigation methods are border (75 %), furrow (17%) and sprinkler irrigation (8%). Although the water which is flowed to the scheme is measured, it is not measured at the distribution points in the fields. Approximately 31% of the total water are surface runoff. The main problems in the irrigation scheme are inappropriate institutionalization, no measuring water and no applying the penalties to the farmers. All these cause over irrigation and lower irrigation performances. In this article, the main problems on irrigation management and operation are discussed and some critical solutions are also presented.

Key words*: irrigation, irrigation management, operational problems, Devegecidi Dam.*

INTRODUCTION

All over the World, the gap between water demand and supply is widening fast due to rapidly growing water demands, driven by an increasing population and economic activities, linked to urbanization, industrialization and mechanization (Majhi, 2011). The global consumption of water in agriculture is approximately 70% of the total water use. At a global scale, increasing competition from domestic and industrial uses has put more pressure on irrigation water availability, threatening the sustainability of irrigated agriculture, further threatening the food security (Khan et al., 2006). Irrigation is the largest water user worldwide. Irrigation water availability is highly sensitive to climate change (IPCC, 1995) and irrigation allocation limitation (Singh et al., 2005).

Irrigation is the largest water user in many countries. International Commission on Irrigation and Drainage (ICID) and our National Committees have played an important role in promoting the integrated water management and sustainable irrigated agriculture for food, fodder and fiber production. Since the agriculture is an important sector of Turkey's economy, the Government pays much attention to irrigation infrastructure investment and irrigation management within the framework of integrated water management concept (Gündoğdu, 2013).

Cropping systems are planned based on available soil, climate and water resources to obtain maximum production. Management of

water supplies for irrigation is one of the most critical water-related problems especially in arid and semiarid agricultural lands. The objective of efficient and sustainable water management in an irrigated cropland is to ensure optimum linkage between water availability and water demand. This is best done by matching demand for water in terms of crop water requirements and available water supplies in time and in the required quantity (Chakraborti, 2013).

Improving productivity of water use is agriculture is an important part of the overall framework for management agricultural demand for water, thereby increasing the ability of agencies and other relevant institutions and organizations to transfer the water thus "saved" to economically more efficient or other high priority use sectors.

However, the increase of water demand, associated with the rapidly growing population and competition between industrial, domestic, touristic and agricultural sectors, amplified the need for a better management of the resource to avoid harming the performance of the irrigated sector.

The operation and maintenance activities (O&M) of irrigation schemes were carried out by the governmental organizations till early 1990s in Turkey. Subsequently, the governmental organizations have been transferred O&M of irrigation systems to Water User Organizations (WUOs).

On the other hand, the operation, maintenance and management of irrigation schemes play a critical role in terms of sustainability of irrigation and water which is a natural resource. In this article, Devegecidi Dam and Irrigation Scheme in Southeastern Anatolia Region of Turkey are evaluated and critized by using especially physical indicators.

MATERIALS AND METHODS

Devegecidi dam and irrigation scheme are in the region of Southeastern Anatolia of Turkey. The main water resources for the dam are Devegecidi Creek. The watershed of the dam is originated by the lands which has got altitudes between 580 and 730 m (Figure 1). The slope of the lands ranges from 0.5% through 10%. The irrigated areas are dominated by storage reservoirs (dams) supplying only the surface waters conveyed through large open channels.

Yearly average precipitation and evaporation are 475 mm and 897 mm, respectively. In summers, the rainfall ranges from 0.6 mm through 7.9 mm. In the irrigated areas, the soils have, in general, clay texture and flat lands. There are no significantly drainage problems. Irrigation water quality is reasonable and salinity level is 0.45 dS/m.

Figure 1. Devegecidi Dam and irrigated area

Irrigation dam, Devegecidi Dam, and irrigation scheme were built in 1971. The irrigation scheme was operated and maintenanced by State Hydraulic Works (DSI), governmental sector, between 1971 and 1994. The governmental organizations have been mandated to transfer O&M of irrigation systems to Water User Organizations (WUOs) of Devegecidi. All characteristics of Devegecidi Dam are given in Table 1. The main canal flow is 9.3 m^3/sec.

It has a gross command area of 10 044 hectares. The average land holding in irrigation district is 2.5 ha. Water to the scheme is delivered by means of the main conveyed canal (9.3 m^3/sec., max. capacity). The irrigation comprises 47 km of main canals, 13 km of secondary and 126 km of tertiary canals. Irrigation district is 2.5 hectares. The irrigation scheme is criticized and evaluated by using some physical performance indicators, such as the rate of irrigation [(RI) = irrigated land (ha)/irrigable land (ha)], rate of relative water supply (WS = diverted water to irrigation scheme/gross water requirement of crops), changes in crop pattern, irrigation efficiency

(IE=diverted water from reservoir/net water requirement of crops).

Table 1. Characteristics of Devegecidi Dam

Dam type	Soil backfill supported by rocks	--
Operation purpose	Irrigation	--
Opening date for operation	1972	--
Irrigation area (Planned)	10 044	ha
Irrigated area (in actual, or net irrigation area)	5 800	ha
Watershed area	1 578	km^2
Yearly average flow	187	hm^3
Yearly average precipitation	474	mm/year
Active water volume	194	hm^3
Max. Elevation for operation	757	mm/year
Min. elevation for operation	739.5	m
Max. Volume for operation	219.1	mm/year
Min. Volume for operation	7.28	hm^3
Numbers of spillway Gates	6	--
Max. Capacity for spillway	2580	m^3/s
Crest elevation of spillway	748.5	m
Kret elevation of spillway	759.0	m
Sluiceway capacity	10.5	m^3/s
Sluiceway exit elevation	737.62	m
Irrigation flow module	1.11	l/s/ha

In addition, the observations and some findings on the irrigation schemes are also criticized and commentated.

RESULTS AND DISCUSSIONS

Some Physical Performance Indicators

Flow rates from the watershed of the dam to the reservoir range from 75.5 million m^3 through 424.2 million m^3 depending climate and years (Figure 2).

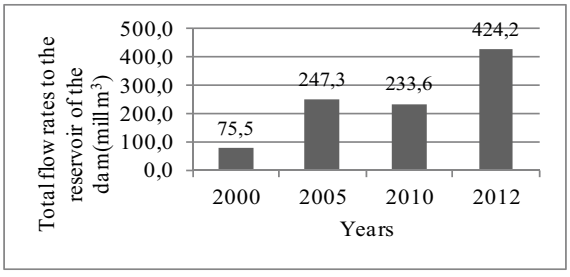

Figure 2. Amount of Water Income the Dam According to Years

The amount of flow rates to the reservoir was dramatically lower in 2000 compared to other years.

The water requirement of crops grown in the irrigation area is considered for the amount of irrigation water released to the irrigation scheme. Meanwhile, this amount of irrigation water is arranged considering irrigation efficiency for this irrigation scheme. Thus, the losses from the canal systems, lands and evaporation are added to the net irrigation water.

Considering the data in Table 2, net irrigated area is ranged from 4250 ha through 5800 ha.

Taking into account the data given in Material and Methods, the planned irrigation area were 10044 ha. whereas theirrigable area is about maximum 6900 ha. However, the irrigated area is lower than irrigable area. There are many reasons on decreasing the irrigable area compared to the first planned area for the irrigation scheme. The main reason was that almost nonirrigated area in the scheme was under the urban settlement area. The differences between irrigable and net irrigated area by farmers are attributed to inappropriate topographical conditions and giving up irrigation for some crops such as cereals.

Depending on given the data previous paragraphs, irrigation ratio (IR) is ranged from 73% through 100% without considering first planning area. Ignoring the area under the urban settlement, IR is reasonable. In a study, concerning irrigation schemes (ISs) in Turkey, carried out by Beyribey (1997), IR were as lower than 30% in ISs of 74, between 30% and 60% in ISs of 72 and higher than 60% in ISs of 53.

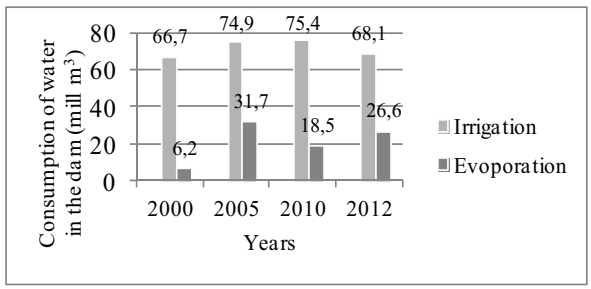

Figure 3. Consumption of Water in the Dam According to Years

Overall irrigation efficiency represents the efficiency of the entire physical system and operating decisions in delivering irrigation water from a water supply, source to the target crop. Thus, this is significantly an indicator in terms of system performance (Irmak et al., 2011).

Irrigators can make a number of management changes to improve application efficiency, maintenance of the canals, field length,

charging set times, field leveling and avoiding exceed irrigation are examples.

The present efficiency which includes the irrigation system efficiency, being combined conveyance and distribution efficiency and the field application efficiency from 32% through 45% were found (Table 2).

Irrigation water is conveyed from the reservoir of the dam to the farm or field by constructed concert canals. The maintenance of main conveyance and the other canals (secondary and tertiary canals) were not sufficient to operate the system properly. Canal seepage and the runoff occurred in the field by inappropriate application could have been caused the lower irrigation efficiency.

In this irrigation scheme, the surface irrigation methods are mainly used. The irrigation methods are border (75%), furrow (17%) and sprinkler irrigation (8%). The water which is flowed to the scheme is measured, however it is not measured at the distribution points in the fields. Approximately 31% of the total water are surface runoff. This results that exceed irrigation has been implemented. Thus, Tables 2 and 3, indicates that water is used more than necessary. Compared to the irrigation modules (l/sec./ha) in Table 1 and 2, there has been an exceed irrigation in this irrigation district. Thus, the overall irrigation efficiency is very low.

Sustainable irrigation is at risk due to excessive flooding of lands with inappropriate irrigation methods. Therefore, cultivation plans and patterns should be followed and water must be supplied to the root zone after efficient measurement on a volume basis. Since crop water requirements cannot be reduced to any great extent during irrigations, water–saving can only be achieved during water conveyance, water distribution, system operation and field water application (Kuscu, 2009).

Table 2. Physical performance indicators (Anonymous, 2013)

Years	Irrigable land (ha)	Irrigated land (ha)	The rate of irrigation (RI) (%)	Total water supply (hm^3/ha/season)	Crop water demand (hm^3/ha/season)	Water use efficiency (%)	Irrigation module (l/s/ha)
2004	6900	5600	81	44.79	78.03	32.7	1.7
2005	5800	5800	100	47.11	78.03	35	1.65
2006	5800	5800	100	48.16	70.16	41.2	1.45
2007	5800	5600	97	46.28	68.90	38.28	1.48
2008	5800	5200	90	40.17	61.70	37.11	1.54
2009	5800	4250	73	22.81	41.65	33.95	1.68
2010	5800	5650	97	42.55	75.37	32.18	1.77
2011	5800	4600	79	42.74	53.64	45.42	1.26
2012	5800	5600	97	51.97	68.12	41.20	1.7

Table 3. Irrigation water requirement and Water Use Efficiency Rate for Realized Devegecidi Irrigation plant design in 2012 (Anonymous, 2013)

Irrigation water requirement (m^3)	Months							Total
	April	May	June	July	August	September	October	
Net (irrigation water)	$316x10^3$	$139x10^3$	$6705 x10^3$	$11116 x10^3$	$7751 x10^3$	$2872 x10^3$	0.00	$28060 x10^3$
Gross (used water)	$555x10^3$	$243x10^3$	$11764 x10^3$	$19502 x10^3$	$13598 x10^3$	$5038 x10^3$	0.00	$51960 x10^3$
WUE (%)	56.93	57.20	56.99	56.99	57.00	57.00	-	54.00

Crop Pattern

Irrigation has changed crop pattern in Devegecidi Irrigation District, and the farmers have started to use new agricultural techniques. The application of new agricultural techniques with started irrigation, in areas where the climate is suitable breeding more than one product in the same year, provides new jobs. Considering development and increasing life standard in the region by means of irrigation, the beneficial impacts of irrigation will be (i) increased crop production and increased farm income, (ii) increased cropping intensity and crop diversification, (iii) increased farm employment and (iv) increased farm consumption and increased permanent wealth (Cetin, 2011).

Planned crop pattern in the basin of Devegecidi Dam is given in Figure 4. According to the crop pattern of Devegecidi Irrigation Scheme,

the ratio of cereals was the highest (44.4%) and the second highest ratio of the crops was cotton (13.3%). However, the crop pattern planned has not applied (Anonymous, 2013). Realized crop pattern in the areas is given in Figure 5 (Anonymous, 2013).

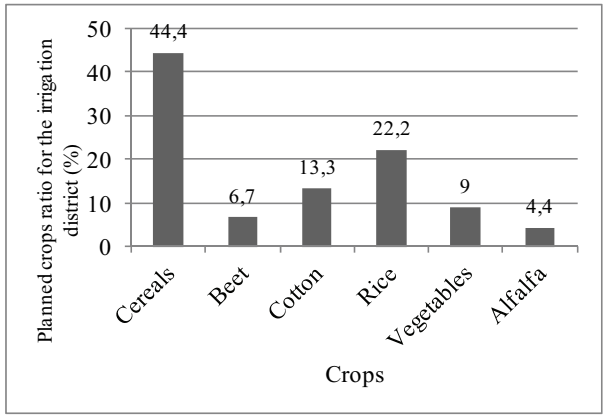

Figure 4. Crop pattern planned for the Devegecidi irrigation scheme

Rice and sesame crops in cropping pattern between the years of 1973 - 1985, while in the later years are not included. Ratio of vegetable cultivation has not been much changed. The cotton, grains and vegetables were mainly cultivated crops. Cotton growing ratio has been ranged from 29% to 97% depending years. Although there were no any cotton crops in the dry areas of the Basin of Devegecidi Region, the ratio of cotton grown has reached dramatically through 97% in the irrigation district area. This situation could be attributed to incomes of cotton growth and subsidizing cotton farming by government. However, besides use of over irrigation, undesired crop pattern applied on the contrary planned crop pattern are the most important problems. These applications indicate that more irrigation water could be consumed or used. On the other hand, many problems might occur; such as soil and water loss, soil and water pollution, soil erosion and soil salinity. Considering different irrigation methods, surface irrigation methods are widely used in Turkey as in this irrigation scheme.

Water scarcity is a major concern for agricultural production in arid areas where the amount of rainfall is limited. Under the water constraint and variability of gross revenue, farmers are more likely to choose high value added crops relative to crop water requirement such as cotton, cereals, corn and vegetables.

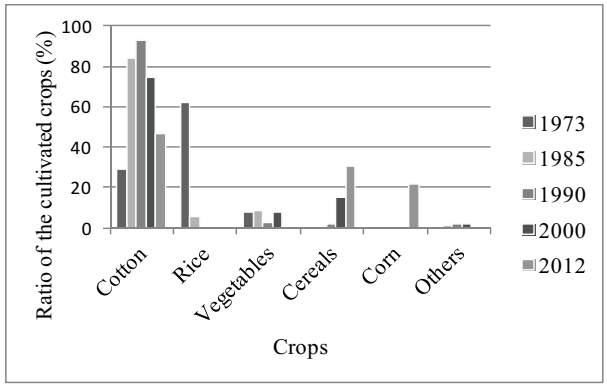

Figure 5. Crop pattern realized for the irrigation scheme by years

Cropping patterns should be adjusted to meet this challenge. The cropping pattern changes can help alleviate water demand competition in case climate becomes drier and the irrigation cap shrinks. Cropping patterns are generally planned according to soil types, irrigation water availability, crop rotation, and water allocation policies, economic and ecological benefits (Subramaniam, 1983; White, 2009).

CONCLUSIONS

In this irrigation scheme, the main problems are lower irrigation ratio, excessive irrigation, soil erosion and lower collecting water charges. In fact, the excessive irrigation and soil erosion occur since the amount of irrigation water applied to the lands of the farmers is not measured. Considering the other inappropriate management of Water User Association (Devegecidi), all these problems occur crucially. Another thing, uninstitutional for the WUA, is a considerable problem.

In evaluation of this irrigation scheme, there are seriously problems, inadequate and deficiencies on operation, maintenance and management of the irrigation scheme. There are different, complex and sophisticated reasons on these because irrigation depends on three main factors. These are technical (engineering), financial (economy) and social situation. Social situation covers such as farmer education level, relationships between farmers, customs of farmers, history, religion, understanding the democracy, bureaucratic issues etc. All these, affects dramatically the management of irrigation schemes even if the irrigation

systems are accomplished using appropriate engineering and financial components.

Some technical improper practices are inappropriate irrigation methods, sides of cultivation and furrow are the parallel to the land slope, longer furrow lengths, using higher discharges than infiltration rate for the lands, the tenants irrigates instead of the property owner in the irrigation schemes.

Some recommendations for the this irrigation scheme could be as supported the farmers in terms of irrigation and agricultural training, institutionalization, alternative crop growing, applying some penalties for the farmers who does not obey the rules and measurement the amount of irrigation water applied to the lands.

ACKNOWLEDGEMENTS

Some of the data in this study were provided by Technical Branch of X. Regional Directorate of State Hydraulic Works, Diyarbakır.

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