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THE NEED OF SUSTAINABLE WATER USE IN TURKISH AGRICULTURE

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Abstract

Water scarcity has been deeply influencing agricultural production over years. Continuously increasing world population and pressure on natural resources, global warming, inefficient management, and similar factors have caused individuals and governmental authorities to put more emphasis on sustainable use of natural resources, water in this case. Although the population of the world and water being used for irrigation are continuously increasing, water potential in the earth remains constant. This means per capita water consumption will diminish in the future and people will have to find out new strategies for sustainable use of water resources. Because of the sufficient surface and ground water resources in Turkey, an immediate water scarcity problem doesn't appear. However, Turkey is not counted as a water-rich country either. For this reason, the available water resources must carefully be used to provide sustainability for the future generations. The primary purpose of this paper is to develop strategies for sustainable use of water resources in Turkey. The paper is first intended to give basic information about agricultural and water resources. Then irrigation possibilities, irrigation methods, and policies will be discussed. Within the framework of the present policies and applications, recommendations for sustainable use of water resources will be developed.

Keywords; water sources, irrigation, sustainability, Turkey

Introduction

Soil and water resources are the most important natural sources for all countries. Providing socioeconomic development, increasing welfare level and creating competition conditions with other communities, natural resources have a vital role. Water is one of our basic and renewable resources, but its availability is variable and limited. Surface water and ground water are both important sources not only for human use but also for ecological systems (Calzadilla et al.). Water is essential for maintaining an adequate food supply and a productive environment for the human population and for other animals, plants, and microbes worldwide (Pimentel et all, 2004).

Nearly every country in the World experiences water shortages during certain times of the year (Gleick, 1993) and more than 80 countries now suffer from serious water shortages (Falkenmark and Lindh, 1993). As human populations and economies grow, global fresh water demand has been increasing rapidly (Hinrichsen et al. 1998, Postel 1999, Rosegrant et al. 2002, Shiklomanov and Rodda 2003, Unep 2003, Gleick 2004).

Agriculture is the major user of water in the world. According to FAO (2013), at global level, the withdrawal ratios are 70 percent agricultural, 11 percent municipal and 19 percent industrial. Globally, around 50 percent of the water withdrawn for agriculture is consumed through evapotranspiration. Agriculture is responsible for approximately 70 percent of water withdrawals, but 90 percent of the water consumption (Kohli et al., 2012). In Turkey the usage of water ratios are 74 percent irrigation and livestock, 15 percent municipalities and 11 percent industrial, respectively. According to MOD (2013), Turkey is among the countries which have water constraint because of its per capita (1,645cubic meters) amount of water. In terms of renewable water sources, countries are classified in two groups; one of them is water-rich countries owning more than 10.000 m^3 per

capita renewable water sources, and the other one is water-poor countries owning less than 1000 m^3 per capita renewable water sources (SHW, 2013). In Turkey per capita renewable water amount is 345 m^3/person and this number verifies that Turkey is not among the water-rich countries.

Materials and Methods

This study was based on an extensive review of literature . The main material used included documents, reports, and statistics from the Ministry of Food Agriculture and Livestock, State Planning Organization, and State Hydraulic Works. In addition earlier journal articles, books, and proceedings were utilized.

Results and Discussion

Turkey shows different characteristics in terms of its geographical location. Length of total boundaries is 10.765 km consisting of 2.949 km length of land borders and 7.816 km length of coastal boundaries. Turkey's neighbors are Greece and Bulgaria from the west, Georgia, Armenia, Azerbaijan / Nakhichevan, and Iran from the east, and Iraq and Syria from the south.

Climate

Rainfall is heavy, especially in the mountainous coastal regions of Turkey (1.000 ~ 2.500 mm / year). In the Marmara and Aegean regions; and in plateaus, and mountains of the Eastern Anatolia region rainfall is 500 ~ 1,000 mm / year. Rainfall in many parts of Central Anatolia and Southeast Anatolia is 350 ~ 500 mm / year. The Salt Lake and its surrounding areas take the least rainfall in Turkey (250 ~ 300 mm / year). However, depending on the seasons and the altitude, sufficient solar energy makes it possible to grow subtropical fruits (bananas, citrus fruits) in Turkey.

Land Resources

Turkey covers an area of larger than 78 million hectares (783.577 km^2) (Table 1). This area includes approximately 28.05 million hectares (36%) of agricultural land. Approximately 92% of agricultural land (25.75 million ha) is irrigable. According to surveys conducted by State Hydraulic Works (SHW), with the existing water potential, it is possible to technically and economically irrigate 8.50 million ha of land. Of this area 5.50 million hectares of land is presently irrigated. Approximately 3.21 million hectares of land is irrigated by SHW which built modern irrigation network in different regions.

Table 1. Land Resources of Turkey, 2013

Land Resources	**Million Ha**
Total area	78.35
Area of arable land	28.05
Area of irrigable land	25.75
Arid land	7.25
Economically irrigable land	8.50
Irrigated area	5.50

Source: SHW

Water Resources

Turkey's average annual rainfall is 643 mm. This is equivalent to water by volume of 501 billion m^3 (Table 2). Of the total rainfall 274 billion m^3 evaporates from the soil-plant-water surface system and returns to the atmosphere, 41 billion m^3 feet the ground water, 186 billion m^3 is discharged to

lakes and closed basins through streams and rivers (Kulga, 1994). Turkey is divided into 25 hydrological basins. Total average annual surface water potential is 186 billion m^3 and of this amount 98 billion m^3 can economically be developed (Table 2).

Table 2. Potential of Water Resources (Over ground, Underground) in Turkey, 2013

Average annual rainfall	643 mm/year
Total water by volume	501 billion m^3
Total evaporation	274 billion m^3
Infiltration to ground water	41 billion m^3
Surface water	
Annual runoff	186 billion m^3
Usable surface water	98 billion m^3
Ground water	
Annually used ground water	14 billion m^3
Total usable water	112 billion m^3
Water consumption	
Used for irrigation (SHW)	32 billion m^3
House consumption	7 billion m^3
Industrial consumption	5 billion m^3
Total water consumption	44 billion m^3

Source: SHW

On the other hand, the total amount of underground water reserves of Turkey is 19 billion m^3, and of this amount 14 billion m^3 of water can be pulled. The annual sum of ground water and surface water potential of Turkey is 112 billion m^3 (Table 2). Utilization rate of the 112 m^3 water sources is 39%, out of this amount 32 billion m^3 (73%) is used for irrigation by SHW, 7 billion m^3 (16%) for drinking water (16%), and 5 billion m^3 (11%) in the industry.

According to SHW statistics about 28.5% (52.94 billion m^3) of the total 186 billion m^3 of usable water belongs to the Euphrates-Tigris basin (184.92 km^2) which takes place in the eastern part of Turkey. This basin is followed-in area by the Red River basin (78.18 km^2) and Sakarya (58.16 km^2) basin. In terms of annual flow the Euphrates-Tigris basin is followed by the East Sea basin (14.90 billion m^3), the Eastern Mediterranean basins (11.07 billion m^3), and the Antalya basin (11.06 billion m^3), respectively (SHW, 2013).

Over the last 55 years the SHW alone constructed 706 dams and ponds on the catchments, took 3.2 million hectares of agricultural land under irrigation, constructed 5930 flood protection facilities which made it possible to protect 1.4 million hectares of land, and provided 3.31 billion cubic meters of drinking, domestic, and industrial water supply services (SHW, 2013).

The gross irrigated area which was 2.3 million hectares in 1970s increased by 2.4 times and reached to 5.5 million hectares in 2011. According to SHW statistics total of 8.5 million hectares of land could technically and economically be irrigated but only 66% of this area was really irrigated by the end of 2011. Overall, 85% of the irrigation water comes from surface water an approximately half of this is provided by multi-purpose dams. In addition, the canal irrigation technology still dominates, but sprinkler and drip irrigation systems are being implemented rapidly.

Collected from an area of approximately 2.1 million hectares the SHW statistics in 2011 show that 81% of the land is irrigated by surface irrigation methods (furrow, border, and release) while pressurized irrigation systems (sprinkler and drip) is used in the remaining part. Traditional sprinkler irrigation is common and 184.000 hectares of land is irrigated by this method. From the SHW irrigations schemes about 72.000 hectares of land irrigated by drip irrigation method.

Table 3. Irrigation Areas by SHW

Status of Irrigation	Number of Facility	Net Area (ha)	Gross area (ha)
Operated by SHW	55	79.704	95.775
Operated by Irrigation Associations	740	2.209.436	2.654.934
Operated by State Production Farms and Universities	31	17.510	21.041
Operated by Cooperatives	1.384	456.709	548.250
Total	2.210	2.763.359	3.320.000

Source: SHW, 2010

As of 2010, the total number of irrigation facilities was 2.210, and 2.763.359 hectares of land had been taken under irrigation. Of this area 79.704 ha (55 facility) operated by SHW, 2.209.436 hectares (740 facilities) by irrigation associations, 17.510 hectares (31 facilities) by state production farms and universities, and 456.709 hectares (1.384 facilities) by irrigation cooperatives (Table 3).

In addition, the Southeastern Anatolia Project (GAP in Turkish), including the Tigris and Euphrates basins, particularly with a focus of energy and irrigation investments, is the region's biggest economic and social development project. Within the framework of 13 projects which are being planned under the main project of the GAP, 22 dams and 19 hydroelectric power plants with 7.490 initial mw power will be constructed in the region. From these projects a total of 27.4 billion kWh of hydroelectric power will be produced. The projects will give the opportunity to irrigate 1.058 million hectares of farmland. So far 75% of energy projects and 29% of the irrigation projects have been realized.

Conclusion

Soil and water are considered as the most important strategic tolls of the 21st century since scarcity and famine are serious threats. Due to the rapid growth in population and booming in industrial sector, countries may face difficulties in meeting the growing need for water, and therefore water shortages will come up with water crisis in many regions in the next 20-25 years (Evsahibioglu, et al, 2010).

In the world summit of the UN Development and Environment (1992) and in UN water report of 1992 prepared for the World's Water Day, Turkey was presented among the countries where drought would be a serious problem.

According to international standards, the amount of current technical and economic available renewable water per capita per year changes from 1.500 to 1.700 m^3, and these numbers indicate that Turkey is one of the countries with "water stress". The population of Turkey will reach to 80 million by 2025 (TURKSTAT, 2013), and the amount of water will be reduced to 1.100 m^3 per person. These values indicate that Turkey is not among water-rich countries.

There have been many problems with water use in Turkey. Among these are inefficient water resources management, climate changes, primitive irrigation methods, illegally opened irrigation wells, network losses, and insufficient waste water treatment plants, etc. In addition, the amount of water available will not be sufficient because of the increasing demand, drought, and pollution in water catchments. Moreover, issues such as lack of planning, monitoring, and evaluation; lack of control; lack of a common data base and information flow; and lack of coordination among institutions are major problems encountered in the management of water resources (Ay and Kisi, 2011).In order for Turkey to sustainable use of water resources the following recommendations can be listed;

First of all deficiencies and ambiguities in the legislation must be solved. Duties and responsibilities of the institutions must be clarified. For effective water management, coordination and cooperation among all stakeholders must be established.

An effective control mechanism for water resources must be provided. All stakeholders must take adequate measures against water pollution. Because Turkey is facing a rapid population growth more water will be needed in the future. Public must be educated to reduce water wastes. In order to reuse waste water, treatment facilities must be established (Ay and Kisi, 2011).
In order to prevent desertification in agricultural lands excessive water use with the present primitive irrigation methods must be prevented. For this reason, farmers must be encouraged, and even supported to adopt modern irrigation methods which will reduce water consumption, as well as prevents soil desertification. Water potential of Turkey must be correctly determined and sustainable use for all citizens must be ensured (MOD, 2013).
National watershed classification system should be developed so as to allow the sustainable use and protection of water resources. River basin management should be carried out by one effective organization. The working process of irrigation associations must be revised. Their system need to be more effective.

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