

1. Introduction

Groundwater is a part of hydrological cycle. And. Water evaporates from water bodies, condensed in clouds, falls as a precipitation such as rain, snow. When it reaches land, surface runoff starts. When top soil is saturated, water infiltrates. Finally, it recharges groundwater. The flow in groundwater systems is part of the hydrological cycle (Stauffer, 2011). There are different layers which have different characteristics storing groundwater. These differences affect quality and quantity of groundwater.

Groundwater is especially used in areas where the usage of surface water is not possible or not convenient (Vliegenthart et al, 2007). If groundwater potential is suitable both quantity and quality, groundwater consumption has the great importance.

The moving from dry agriculture to irrigated one depends on water resources as much as land resources and irrigation methods. Hence, the investigation of potential of land and water resources is a great importance on irrigation projects. Water has the key role for limiting crop pattern and production.

In Turkey average annual precipitation is 643 mm. It is ranging from 250 mm to 3 000 mm. It shows unevenly distributed water regime in time and space. This precipitation figure forms the origin of the water resources of Turkey and corresponds to an average of 501 billion m³ of water per year. Some of it evaporates from the surfaces, transpires through plants, forms surface runoff, feeds rivers and recharges aquifers. As a result of this cycle, limited water is stored in the aquifer. However, all of water stored in aquifer cannot be utilized because of technical and economical reasons. As per 2014, groundwater potential reserve of Turkey is approximately 21,8 billion m³/year but exploitable groundwater resource or groundwater management reserve is 17,2 billion m³ /year. At present, DSI has allocated total groundwater of 13,560 billion m³/year, 3,820 billion m³/year of which is for DSI, public, and GWO irrigations 4,772 billion m³/year of which is for domestic and industrial purposes, and 4,968 billion m³/year of which for individual farmer use (Kalkan and Isci, 2014).

2. Agricultural Groundwater Management

The groundwater activities in Turkey have been executed by the State Hydraulic Works (DSI) on behalf of the State according to the Law on Groundwater (law No. 167). It was brought into force in 1960. According to the Law, groundwater is under the control and ownership of the State. Any research, allocation, utilization, protection and registration of groundwater are the main characteristics of the Law. Within the framework of the Groundwater Law, whenever and wherever each person intends to construct a water structure in order to provide groundwater (such as drilling well, excavating galleries or tunnels, etc.), they should get license from DSI.

Law No. 167 puts in order on groundwater:

- conduct surveys of groundwater and drill;
- deep wells or have them drilled;
- transfer or lease deep wells;
- protect and record groundwater; grant licenses for survey, use and rehabilitation and modification of wells.

Besides, in accordance with the aims indicated in the Law on Groundwater; Regulation on Groundwater and Technical By-law on Groundwater were prepared in order to apply the Law efficiently. Technical By-law covers technical details. Groundwater irrigation management is performed in four types. These are;

- Groundwater Irrigation Cooperatives,
- DSI Groundwater Irrigations,
- Public Institutions Irrigations
- Individual Farmer Irrigations.

The ratio of groundwater irrigation areas which are irrigated from facilities built by DSI has been shown at Table 1. DSI.

Type	Percentage
Irrigation Cooperatives	72
DSI Groundwater Irrigations	15
Public Institutions Irrigations	13

TOTAL	100
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Table 1. The ratio of groundwater irrigation areas

2.1. Groundwater Irrigation Cooperatives

All process of Groundwater Irrigation Cooperatives (GIC) subject to related Law is being implemented by Agricultural Development Sectional Directorate of Province Special Administration. The establishment process of GIC is as follows:

7 farmers are to be come together to form a commission to demand GIC.

The commission consisting of 7 farmers with their proof of residence and their copies of identity cards are to sign a petition demanding to set up a particular kind of GIC are to apply to Provincial Directorate of the Ministry.

The administrative units of Provincial Directorate prepares Phase 1 investigation data and dispatches them to Geotechnical Services and Groundwater Department of DSI General Directorate who investigates the status of the groundwater in the area.

Investigation and appraisal Sectional Directorate of Geotechnical Services and Groundwater Department of DSI General Directorate demand the related DSI Regional Directorate to investigate the area if the groundwater status is suitable or not.

The related DSI Regional Directorate informs Investigation and Appraisal Sectional Directorate of Geotechnical Services and Groundwater Department of DSI General Directorate if the groundwater is suitable. The Sectional Directorate dispatches the 1/2500 scaled maps and the size of the area (ha) to be irrigated and demands that Phase 2 date are to be prepared.

The prepared Phase 2 date are to be delivered to Planning and Reserve Sectional Directorate of Geotechnical Services and Groundwater Department of DSI General Directorate who prepare feasibility report. Planning and Reserve Sectional Directorate used to prepare feasibility reports.

The bore holes are drilled after the feasibility reports are prepared and sanctioned. Then, the Provincial Directorate construct their irrigation network, thence irrigation begin.

Groundwater activities concerning irrigation cooperatives are jointly carried out by DSI and SPA. There is an agreement between these two organizations. All activities are followed according to the agreement. This agreement consists of responsibility of two organizations. Farmers establish irrigation cooperatives, and want DSI or SPA to construct irrigation schemes.

In the content of this activity, responsibilities of DSI are following; Hydrogeological survey is carried out. If groundwater quality and quantity is suitable, feasibility report is written, if it is optimal, project is started. Groundwater wells are drilled. Electrification systems are built. Pumps are provided and mounted. Shortly performing of hydrogeological survey, preparing of feasibility reports, drilling of wells, building of electrification systems and providing of pumps are under the responsibilities of DSI. Irrigation systems can be constructed by either of them- DSI or SPA.

All schemes (wells, pumps, electrification systems, irrigation systems) are transferred to the cooperatives namely users. All investment cost constructed by DSI is refunded in 15 years by users without any interest. First three year is called as adaptation period. They do not pay during this period. It is paid in 12 years as equal shares without any interest.

As of 2014, an area of 482 275 ha has been irrigated by means of 11 700 deep wells by Groundwater Irrigation Cooperatives. Presently, there are 1,400 irrigation cooperatives, intensely in Konya, Isparta, Eskişehir, Kayseri, Edirne, Samsun, and İzmir.

2.2. DSI Groundwater Irrigations

This type of groundwater irrigation is performed to supply groundwater into irrigation canal where surface water is insufficient. Operation and maintenance services were made by DSI. These services led to financial problems and system performance was decreased. In order to overcome these problems, operation and maintenance services are transferred to Water User Organizations. As of 2014, 2051 deep wells are used in 100 470 ha of DSI groundwater irrigations. From year to year, the responsibility of operation, maintenance and management of these irrigation networks are being transferred to irrigation organizations.

2.3. Public Institutions Irrigations

In the need of Public Institutions, mostly Agricultural Enterprises (TIGEM), all equipment related to irrigation schemes are provided by DSI. DSI drills groundwater wells and provides irrigation schemes with equipments on the cost recovery base. Afterwards, they are transferred to public institutions. The operation of these projects is performed by related institutions. As of 2014, in 32 projects with 2 161 drilled wells, 84 080 ha area have been irrigated by groundwater.

2.4. Individual farmer Irrigations

As per related law, land owners or farmers can irrigate their own fields from individually operated groundwater wells. To operate them, farmers have to get a user's license from DSI if the well depth is more than 10 meters. This permission depth is decrease to 5m in some extraordinary conditions of coastal areas to avoid from sea water intrusion. Each farmer who wants to consume groundwater for irrigation should get license from DSI according to the Law on Groundwater. 3.430 billion cubic meters was allocated for individual groundwater irrigations. 273,962 user's licenses have been granted for individual irrigations..

Two methods are applied for this. If farmer can afford investment cost of all irrigation schemes such as construction and providing equipment, Local Authority of Rural Service makes only irrigation project. That is the first one. If farmer can not afford these, it is financed by Agricultural Bank credits. This is another way.

Shortly, DSI allocates groundwater, Local Authority of Rural Service makes technical support and Agricultural Bank gives credit.

Where surface water is not available, it can not be denied the benefit of groundwater. For these areas, groundwater is the main source for irrigation.

Groundwater irrigation schemes have an important role in rural area. It leads to increasing of income so migration to big cities is prevented through groundwater irrigation schemes. At the all types of irrigations, open canal systems were used mostly but recently with a view to saving water and increasing irrigated area per unit water, modern irrigation systems such as sprinkler and drip irrigation have been started to apply.

3. Result

Rivers in Turkey have generally irregular regimes. The average annual precipitation, evaporation, and surface runoff varies with respect to time and geography. In this context, agricultural groundwater management is very important and critical issue for the country. From year to year, operational rights of these irrigation networks are being transferred to irrigation organizations. There are several organizations responsible for development, management and conservation of groundwater resources. DSI, as a water authority, is the main organization responsible for development, management and conservation of groundwater resources. The responsibilities of SPA include supplying potable water to the rural communities (especially villages) by drilling well, designing irrigation projects to individual farmer irrigations, on-farm development and construction of irrigation channel for irrigation cooperatives. Foundation of irrigation cooperatives and education of the farmers are performed by Ministry of Agriculture and Rural Affairs.

Groundwater has been over extracted therefore the government initiated some measures to control the use of groundwater. Some gauging systems have been necessary in order to measure the groundwater use. As per Law, it has been imperative that gauging systems are to be installed in boreholes. "DSI Groundwater Gauging System Regulation" come into effect in 2011.

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