Determination Of Groundwater - Surface Water Relation By Using Environmental Isotopes At Sultansazlığı Wetland-Turkey

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ABSTRACT[1]

Sultansazlığı Wetland is placed in Develi Closed Basin in Turkey and it is one of the seven important wetlands of Turkey and the second important bird habitat of Turkey. Sultansazlığı Wetland is also known as one of the most important wetlands of the Eastern Europe and the Middle East. There are Yay Lake, Çöl Lake, North and South marshland areas in Sultansazligi Wetland Region. This wetland area is a conservation area protected by International Ramsar Agreement. Water level of Sultansazlığı Wetland had been decreased in the recent years and also there is an irrigation water supply problem in Develi Closed Basin. There are many illegally opened wells in Develi Closed Basin. In order to find out the effects of water scarcity in Sultansazlığı Wetland; environmental isotopes are used to determine surface water of wetland and groundwater intrusion. Tritium (H^3), deuterium (H^2), oxygen18 (O^{18}) are used as environmental isotopes in this study. Total 44 bottles of water samples had been taken from the groundwater (from springs and wells) and surface water of Sultansazlığı Wetland (from Eğri and Sap Lake) during 2003-2005 time period. Oxygen 18, Deuterium and Tritium analysis of these water samples had been made at the isotope laboratory of State of Hydraulic Works (DSI). It is found out that there is no direct relationship between the surface water of Sultansazlığı Wetland and groundwater under the wetland according to the isotope analysis.

Key Words: *Isotope hydrology, surface water-groundwater interaction, Sultansazliği Wetland*

Introduction

Sultansazlığı Wetland is located in Develi Plain which is located at the southwest side of the Erciyes Mountain. Average elevation of Develi Plain is 1150 m and its surface area is approximately 800 km^2. Develi Closed Basin is one of the sub-basins of Kızılırmak Basin (Figure 1). There are Yay Lake, Çöl Lake, Southern and Northern Marshlands in Sultansazlığı Wetland. This wetland is a conservation area protected by International Ramsar Agreement since 1994. Sultansazlığı Nature Conservation Area is placed at the south of Kayseri city, its area is a triangle about 10 000 hectares among Yeşilhisar, Yahyalı and Develi towns. Çöl and Yay Lakes are rather shallow lakes. The Northern and Southern marshlands besides Yay Lake and Çöl Lake are entirely dry during irrigation period because there is no required water to feed this wetland and also the rates of evaporation and evapotranspiration are very high. According to the conceptual model (Figure 2) defining the interrelation among the components of surface and subsurface water of Sultansazlıgı Wetland. Marshlands and Yay Lake are fed by the precipitation (rainfall and snow) and by the irrigation return flow. There are many springs in the area and the discharge of these springs is used for the irrigation. Therefore springs can partially feed the wetland only during winter. There are three dams for irrigation purpose in Develi Closed Basin but total irrigation area is very large, surface water which is supplied from these dams is not sufficient so many deep wells had been drilled to use groundwater for irrigation.

Geology of the Project Area

At the south of Develi Closed Basin, there are metamorphic rocks such as limestone, schist and gneiss. Coral fauna was found (age of coral was 370-410 million years) at the south of Yahyalı District. At the northern side (nearby Erciyes Mountain), there are volcanic rocks such as andesite and basalt. At the east and west parts, there are volcano-sedimentary formations. Magmatic rocks are placed as a strip along north-east direction (DSI, 1995). Sediment formation contains sand, gravel, clayey silt and

silty clay at Develi Plain. Sediment thickness is about 350-400 m at the middle part (*where wetland area is located*) (DSI, 1970; DSİ, 1995)**.** Sediment particle size reaches from gravel and sand size to the carbonate clay and silty clay size while going from the northern side to the middle part of Develi Plain. There is crystallized limestone, schist and gnays at the southern part of Develi Plain. Tuff-agglomerate- andesite and basalt lie down through the inside of the plain with different depth and thickness (DSI, 1995).

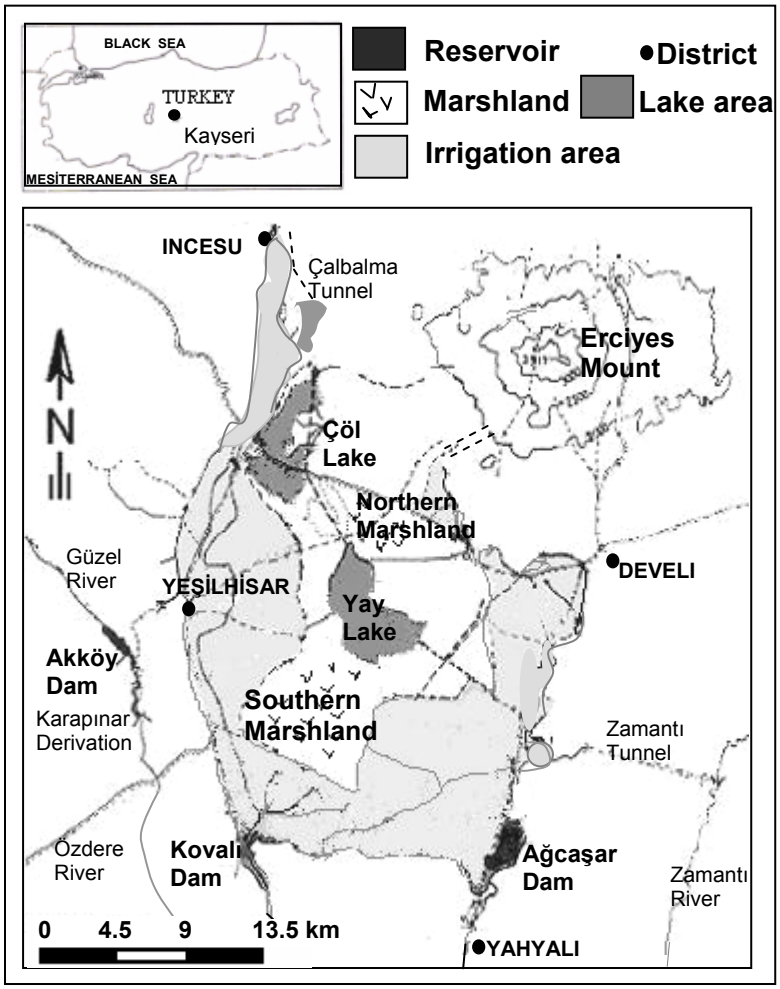

Figure 1. Sultan Marshes and surrounding first and second phase irrigation projects (modified after DSI, 1988).

Isotope Analysis

Definitions

Environmental isotopes are used to define groundwater velocity, to determine the origin and the age of the groundwater, to determine groundwater-surface water interaction and also to trace water pollution and water leakage. The environmental isotopes occur naturally and they are found abundance in the environment. Oxygen-18, Deuterium and Tritium are commonly used isotopes in isotope hydrology (Gürer, 2003).

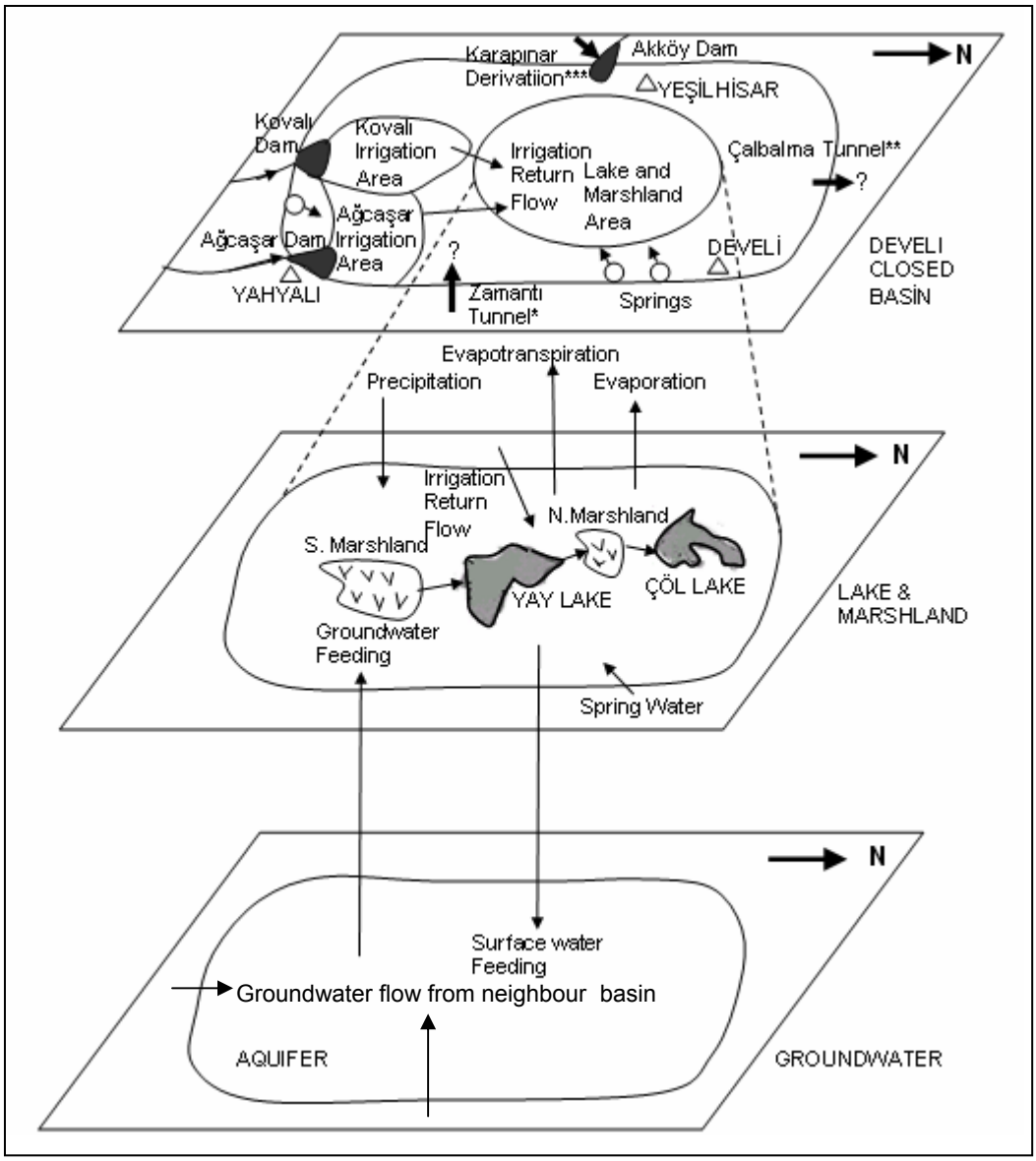

Figure 2. The conceptual model showing the interrelation among the water components of surface and subsurface water. *Zamantı Tunnel is under construction, there is no inflow yet,
** There is no excess water in the basin so there is no outflow from Çalbalma Tunnel,
*** There is no inflow from Karapınar Derivation Tunnel
(modified after Yıldız, 2007; Gürer and Yıldız, 2007).

Methodology

Environmental isotope analyses were carried out in order to determine the relationship between the surface water of Sultansazlığı and the existing groundwater aquifer under the wetland. Tritium (H^3), Deuterium (H^2), Oxygen18 (O^{18}) were used as tracers in the content of this study. Total 44 bottles of water had been sampled from the groundwater (from springs and wells) and surface water of Sultansazlığı Wetland (from Eğri and Sap Lake) during 2003-2005. Isotope tests were made at the isotope laboratory of Technical Research and Quality Department of Turkish State of Hydraulic Works. Water samples were collected by using plastic bottles, water samples were reached to the isotope

laboratory immediately. Taking water sample from Eğri Lake, deep well and spring can be seen in Figure 3.

Deep well # 46537 Soysallı Spring Eğri Lake

Figure 3 . Taking water sample from Eğri Lake, deep well and spring

Non radioactive isotopes are called as “stable isotopes”, their concentration does not change by time in closed systems. Their isotopic concentrations are measured according to the difference between the sample and the reference. Isotopic concentration of the stable isotopes is symbolized as (δ). Figure 4 shows the locations where water samples had been collected during 2003-2005 for the isotope analysis.

Deuterium and Oxygen 18 concentrations of the water samples which had been taken from Develi Closed Basin are shown in Figure 5.

When Figure 5 is examined, it can be said that isotopic concentrations of the water samples taken from the surface water of Sultansazlığı (Eğri and Sap Lakes) are different from the isotopic concentrations of the water samples taken from spring water and deep well. Intersection point of the Global Meteoric Water Line and the evaporation line represents the original isotopic concentration of the surface water samples before evaporation. This point is called as “Original water point” and shown as point “A” on Figure 5.

It can be said that the isotopic concentrations of most of the groundwater samples are different from the isotopic concentrations of “Original water point” (Figure 5), so the origin of the surface water of Sultansazlığı Wetland is different when compared with the groundwater samples. Isotopic concentrations of the groundwater samples SK2, SK6, SK7, SK8, SK23 and SK 25 are close to the isotopic concentrations of “Original water point” according to Figure 5.

Deep wells, where SK2 and SK 23 samples had been taken, are close to Çalbalma Pumping Station (Figure 4). These wells can be polluted by the drainage water of Çalbalma Pumping Station (electrical conductivity of SK 2 and SK 23 are very high 8015 and 3010 mohms/cm respectively). Isotropic concentrations of SK2 and SK23 are close to the isotropic concentrations of “Original water point” because of the drainage water pollution.

SK 25 had been taken from the shallow well which had been located at the southern of Southern Marshland. Water of Southern Marshland is infiltrating and feeding this shallow well so isotropic concentration of SK 25 sample is close to the isotropic concentrations of “Original water point”.

Groundwater flow model for the deep wells where SK6, SK7 and SK8 water samples had been taken is shown in Figure 6. Oxygen 18 and Deuterium concentrations of SK6, SK7 and SK8 are close to Oxygen 18 and Deuterium concentrations of “Original water point”. So Tritium analyses were made to

these water samples to determine if is there any relationship between SK6, SK7 and SK8 and the surface water of Sultansazlığı. Groundwater dating according to tritium concentration is presented in Table 1.

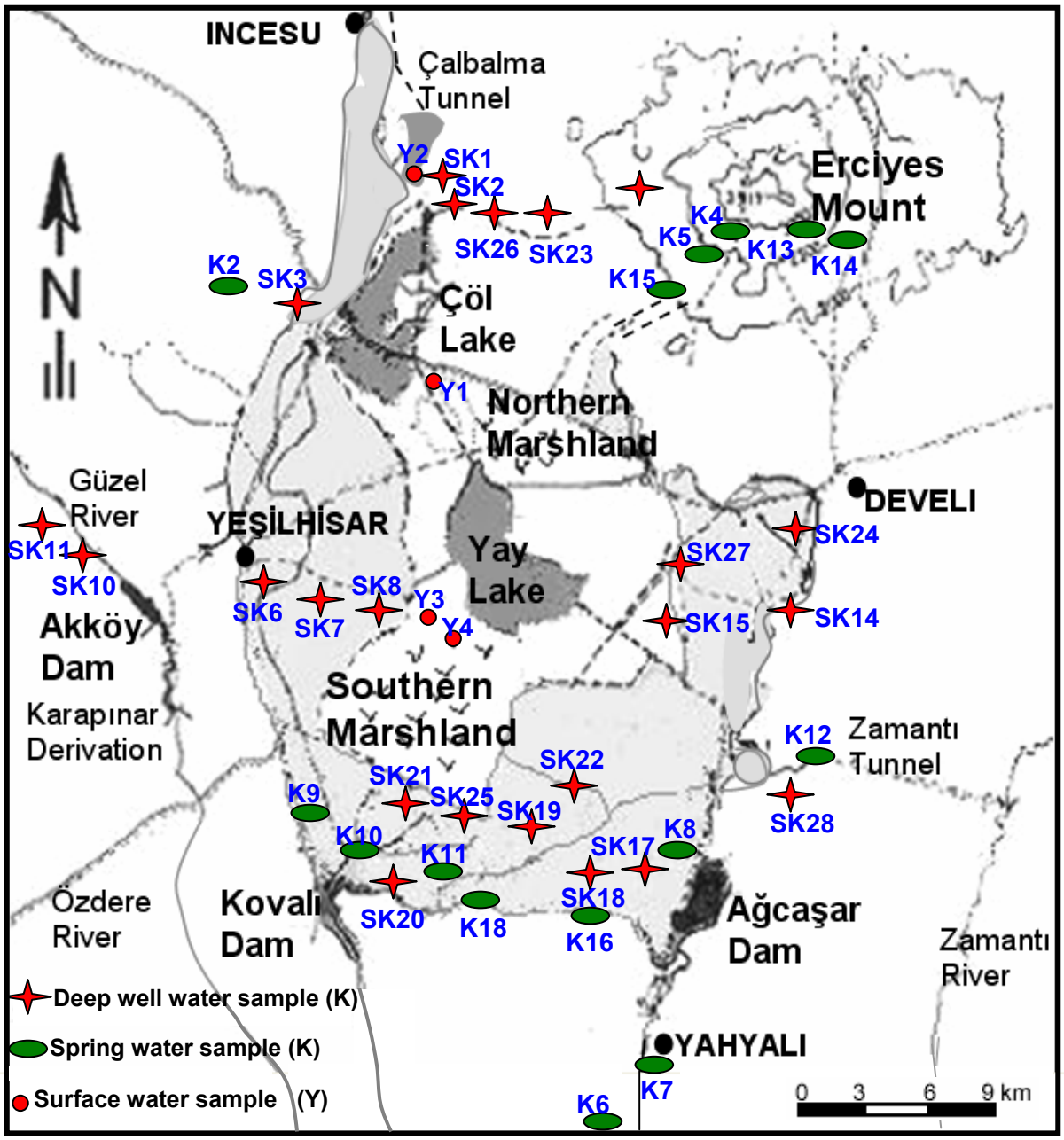

Figure 4. Locations of the water samples which had been collected at Develi Closed Basin (Yıldız, 2007)

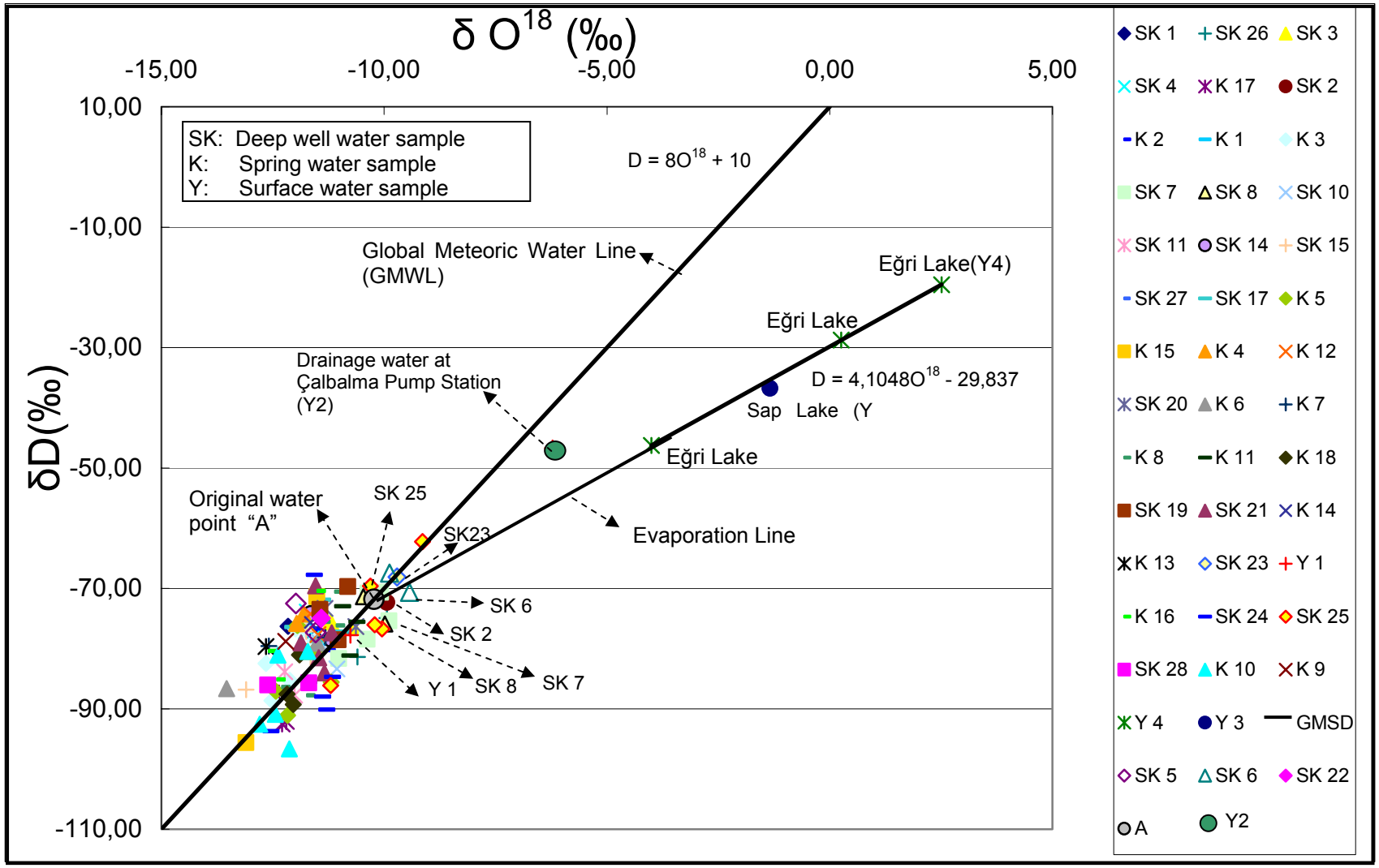

Figure 5. Isotopic concentrations of Deuterium and oxygen 18 of the water samples on Global Meteoric Water Line (Yildiz, 2007)

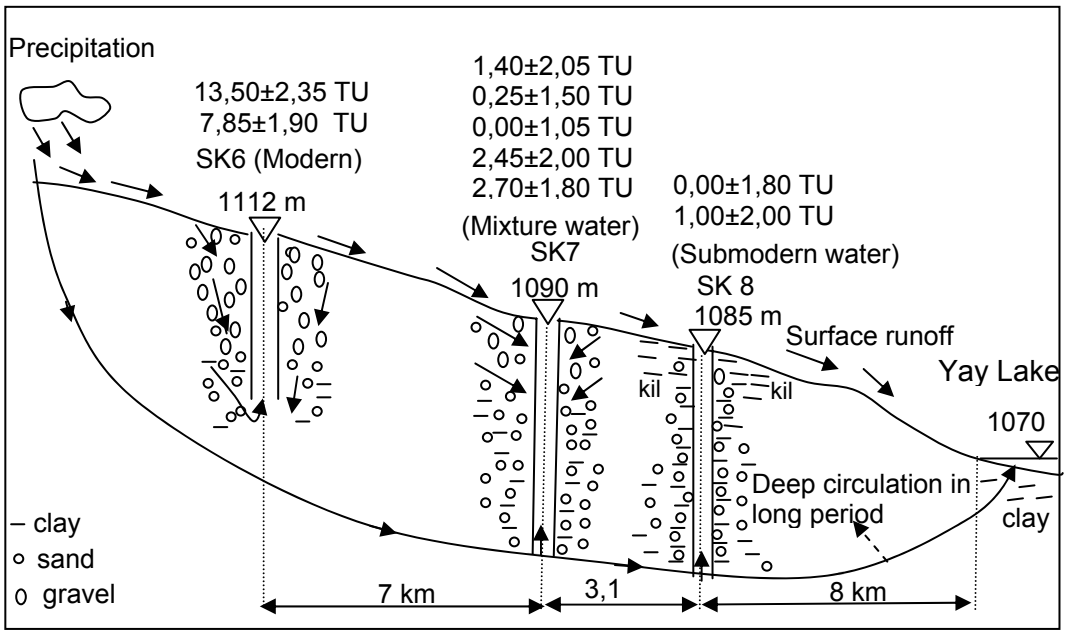

Figure 6. Groundwater flow model of the deep wells where SK6, SK7 and SK8 had been taken (Yıldız, 2007).

Table 1. Dating groudwater according to its tritium content (Clark & Fritz, 1997)

Tritium content (TU)	Age / Period of groundwater
< 0,8 TU	Submodern, recharged prior to1952
0,8 – 4 TU	Mixture between submodern and recent recharge
5 -15 TU	(5 -10 year)modern water

Two water samples from the well SK6 are modern water, five water samples from the well SK7 are mixture of modern and submodern water and two water samples from the well SK8 are submodern water according to Table 1. Deep well SK8 is the closest well to Yay Lake but water of this well is submodern so there is not relation between the groundwater of this well and the surface water of Sultansazlığı wetland. Deep well SK6 is being fed by the precipitation and deep well SK7 is being fed by the precipitation and submodern groundwater. It is thought that groundwater of these wells has not relationship between the surface water of Sultansazlığı Wetland.

Conclusion

According to the isotope analyses which were done during 2003-2005 time period it was determined that there is not direct relationship between the surface water of Sultansazlığı and groundwater. But groundwater can infiltrate into the clay and feed the wetland in the very long time period. Also surface water of Sultansazlığı can infiltrate into clay in the very long time. Conceptual model about the groundwater flow at Develi Closed Basin can be seen at Figure 7.

Acknowledments

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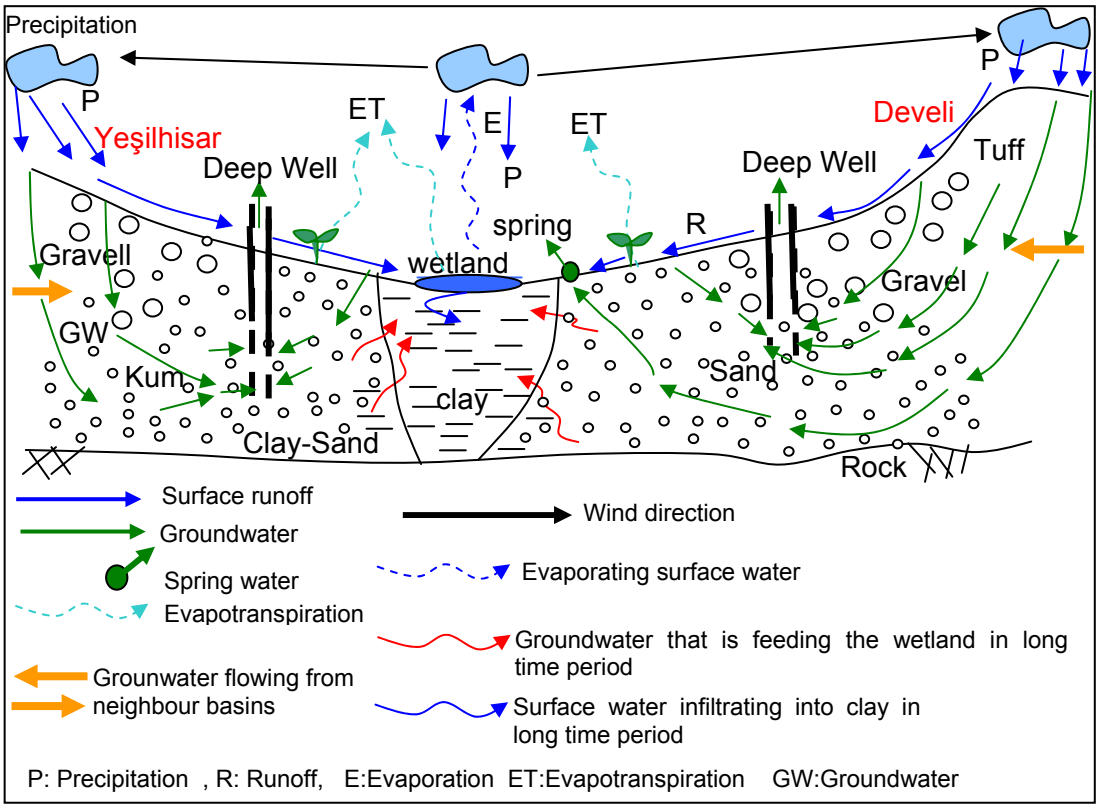

Figure 7. Conceptual groundwater flow model at Develi Closed Basin (Yıldız, 2007).

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