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Seasonal Level Change and Overdraft of Water Wells

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Abstract: In the simplest terms an overdraft, can be expressed as a condition in which the water withdrawn from an underground water aquifer by pumping exceeds the amount that recharges the aquifer via deep percolation. Groundwater aquifers are fed by infiltration from precipitation, surface water bodies, such as rivers and lakes when they are hydraulically connected, and return flows from agricultural and urban uses. Groundwater overdraft is an unsustainable use of limited water resources. Less surface water availability due to rising temperatures and lack of precipitation, and pollution of aquifers are among reasons for excessive groundwater overdraft. In addition to such negative factors, uncontrolled agricultural irrigation also increases the effect of overdraft. For such reasons, it is important to protect the waters with the understanding of sustainable management. In this study, seasonal water heights in observation wells operated at the same water elevation in two different resorts located on the borders of the Uluova basin were examined and water level changes were examined. The periodic (seasonal) water heights of the observation wells in 2011 and 2018 were studied. The effect of overdraft was pointed out through the height changes in the observation wells.

Su Kuyularının Mevsimsel Seviye Değişimi ve Aşırı Çekim

Anahtar Kelimeler
Aşırı Çekim,
Gözlem Kuyusu,
Havza

Öz: En basit ifadeyle aşırı çekim, bir yeraltı suyu akiferinden pompajla çekilen suyun, derin süzülme yoluyla akiferi yeniden dolduran miktarı aşması durumu olarak ifade edilebilir. Yeraltı suyu akiferleri, hidrolik olarak bağlı olduklarında nehirler ve göller gibi yüzeysel su kütleleri ve tarımsal ve kentsel kullanımlardan kaynaklanan geri dönüş akışları ile yağıştan sızma ile beslenir. Yeraltı suyu fazla çekimi, sınırlı su kaynaklarının sürdürülemez bir kullanımıdır. Artan sıcaklıklar ve yağış eksikliği nedeniyle daha az yüzey suyu mevcudiyeti ve akiferlerin kirlenmesi, aşırı yeraltı suyu aşırı çekiminin nedenleri arasındadır. Bu tür olumsuz faktörlerin yanı sıra kontrolsüz tarımsal sulama da aşırı çekimin etkisini artırmaktadır. Bu gibi nedenlerle suların sürdürülebilir yönetim anlayışı ile korunması önemlidir. Bu çalışmada Uluova havzası sınırlarında yer alan iki farklı beldede aynı su kotunda işletilen gözlem kuyularındaki mevsimsel su yükseklikleri incelenmiş ve su seviyesi değişimleri incelenmiştir. 2011 ve 2018 yıllarında gözlem kuyularının periyodik (mevsimsel) su yükseklikleri incelenmiştir. Gözlem kuyularındaki yükseklik değişiklikleri ile aşırı çekim etkisine dikkat çekilmiştir.

1. INTRODUCTION

Today, water; In addition to being of vital importance for human life, health and ecosystems, it is a basic need for the development of countries. Water scarcity is becoming an increasingly prominent and pervasive problem. Water quality is deteriorating rapidly in almost every country. This problem also causes many chained problems in terms of social and economic aspects. In terms of ensuring sustainable development, it is very important to ensure the balance of protection and use. All these elements can only be evaluated within the scope of sustainable water

management. The developing approach in terms of water resources management is to perform resource management on a basin basis and in an "integrated" manner with other natural resources. Integrated management of water resources, which is the driving force for major sectors of socioeconomic development such as energy, agriculture and health, is one of the basic components of sustainable development. Especially basin-based protection [1]. All developments and uses should be directed in a controlled manner while making plans [1]. In parallel with the increasing irrigation areas in our country, problems related to irrigation management have also increased and the realization rate of the expected benefits from irrigation has remained low. When this situation is combined with the policies followed, irrigation and irrigation management will become more efficient and more economical in this context. Today, irrigation management is generally carried out by irrigation unions, irrigation cooperatives, municipalities or village legal entities. As a result, the water crisis has become inevitable all over the world [2]. The growth of the population and the increase in water-based agriculture increase the dependence on groundwater [3-5].
The continuous increase in population, agriculture and industrial activities necessitates the use of more water in every period than in the past. And requires the continuation of water resources management [6]. The excessive use of groundwater due to recent high demand and drought has had sometimes irreversible effects on many aquifers around the world [7]. Wada et al. [8], reported that groundwater overdraft has doubled in the last 50 years in arid and semi-arid regions of the world. Doğan et al. investigated the effects of overdraft on groundwater in a study [9]. Therefore, hydro-economic models are needed to identify the areas most affected by groundwater overdraft and measures to reduce existing groundwater consumption. In this study, the effect of overdraft was investigated by examining 2 underground water observation wells in different locations in Uluova region of Turkey's Elazığ province.

Uluova micro-basin in Turkey's Elazig province is a region where important agricultural lands of the city are located. In addition, a significant part of the drinking and utility water of the city with a population of approximately 500.000 is provided from the wells drilled in this basin.

2. MATERIAL AND METHOD

This study was carried out on the underground water wells in the Yurtbaşı and Yazıkonak regions of Elazığ province. In the study, seasonal water measurements of wells operated for observation purposes in Yazıkonak and Yurtbaşı districts, one of the central districts of Elazığ, located within the boundaries of the Uluova basin, were used. In the period of 2011-2018, water level measurements were used for April, the month with the highest seasonal water level, and September, when the seasonal water level was the lowest. The effect of overdraft on the respective water wells has been specifically studied (Table 1).

Table 1. Seasonal water levels of observation wells

Yurtbaşı Observation Well Data			Yazikonak Observation Well Data		
Years	September	April	Years	September	April (m)
2011	-32.7	-25.2	2011	-22.1	-17.3
2012	-39.5	-29.3	2012	-27.5	-21.3
2013	-33.8	-30.0	2013	-29.3	-24.4
2014	-36.0	-37.0	2014	-30.8	-27.7
2015	-38.7	-33.1	2015	-33.2	-29.0
2016	-40.0	-34.9	2016	-34.8	-30.8
2017	-45.2	-37.0	2017	-38.2	-32.5
2018	-49.0	-41.0	2018	0.00	-37.4

An example diagram showing the urban and agricultural water demands with the Yazıkonak and Yurtbaşı observation wells is given in the figure below (Figure 1). As seen in the diagram, there is a flow feeding the groundwater reservoir. Afterward, water is transferred from the reservoir to the urban and rural water demand points, which are shown in different colors. In this study, since the example of Yazıkonak and Yurtbaşı wells as urban (rural) and agricultural underground water reservoirs is examined, these wells are shown in the network flow chart. There is a flow to the underground wells as shown by the brown arrow in the diagram. This brown arrow represents the flow that goes underground with precipitation. The purple arrows represent water delivered from the distribution point from underground wells to urban and agricultural areas. The gray arrows represent the flow returning from the urban and agricultural demand points by infiltration into the ground.

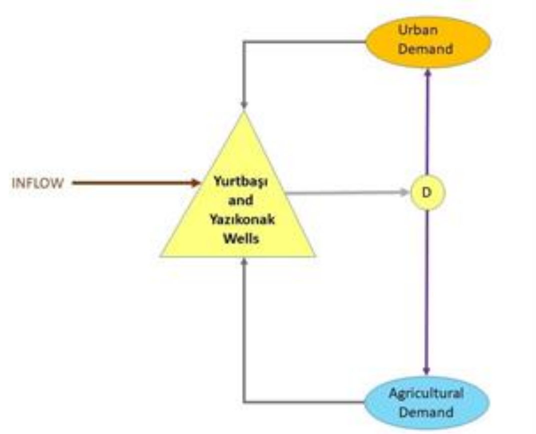

Figure 1. The link between urban and agricultural water demands and wells

In Table 2, the annual average precipitation values of the precipitation station including Yurtbaşı and Yazıkonak regions are given [10].

Table 2. Study area precipitation station data[10]

Yurtbaşı And Yazıkonak Regions Precipitation Statistics	
Years	Annual Average Precipitaion (mm)
2011	33.48
2012	29.00
2013	23.69
2014	27.29
2015	35.08
2016	23.96
2017	16.40
2018	35.36

In Figure 2, the study area where the observation wells are located is given [11].

Figure 2. Working area [11]

3. RESULTS

Seasonal water changes in Yazıkonak and Yurtbaşı observation wells in the relevant time period are examined from the graphs given in Figure 3, Figure 4 and Figure 5. In Figure 3, the water level changes of the Yazıkonak (B) observation well are examined. The black dashed line shows the water level changes in September of the relevant year, and the red dashed line shows the water level changes in April of the relevant year. In the column chart, the blue columns represent September, and the orange colored columns represent the April water level measurements.

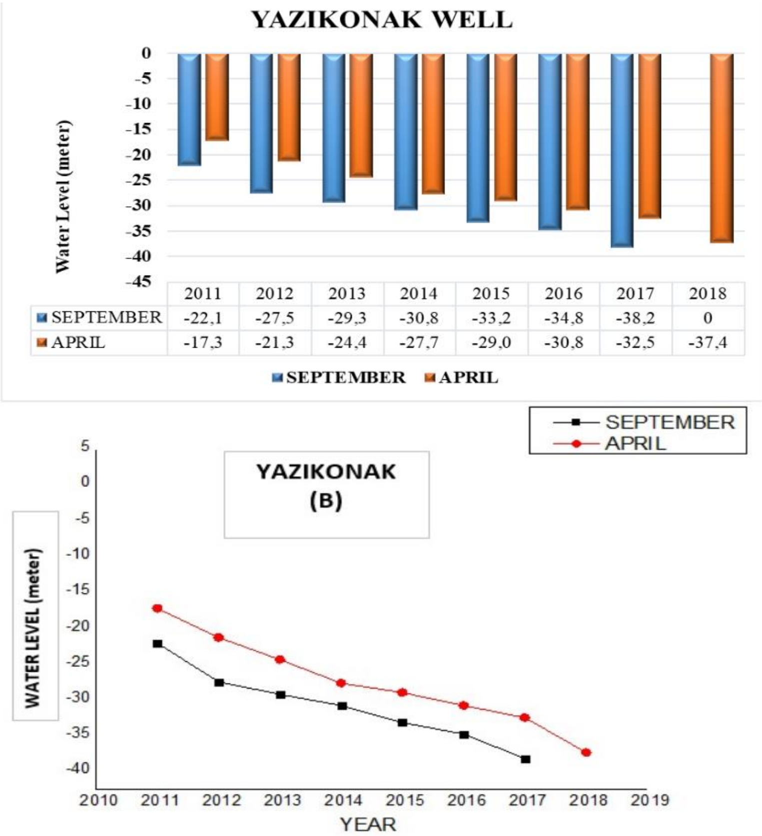

Figure 3. Yazıkonak observation well analysis results

In Figure 3, it was observed that the water level decreased every year from 2011 to 2018 in the Yazıkonak observation well. Due to the lack of water in the Yazıkonak well in September, when the water level was the lowest in 2018, the water level value is not given in the chart. Due to the lack of water in the Yazıkonak well in September, when the water level was the lowest in 2018, the water level value is not given in the chart. Although there was much more precipitation in the Yazıkonak region in 2018 compared to previous years, it is clearly seen that this precipitation did not have any positive effect on the well level. Again, despite the increased precipitation in 2015, the downward trend of the water level in the water well continued.

In Figure 4, the changes in the water levels of the Yurtbaşı (A) observation well are examined. The black dashed line shows the water level changes in September of the relevant year, and the red dashed line shows the water level changes in April of the relevant year. In the column chart, the blue columns represent September and the orange colored columns represent the April water level measurements.

In Figure 4, it is seen that the water level in the Yurtbaşı observation well decreases with each passing year compared to the previous year. It can be said that the water level measured in September and April 2014 is almost the same. This is probably due to the relatively increased rainfall in 2014 compared to the previous year. It has been observed that the level of the well has decreased by approximately 20 m in the period from 2011 to 2018.

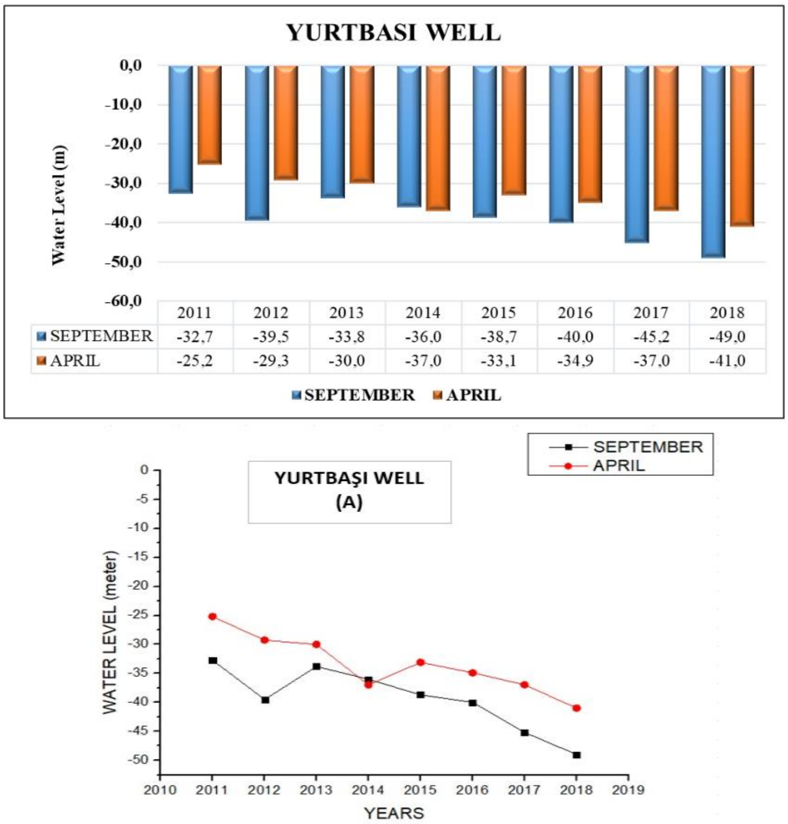

Figure 4. Yurtbaşı observation well analysis results

In Figure 5, the water level changes of the Yurtbaşı (A) and Yazıkonak (B) observation wells are examined together. In 2011, 2012, 2013, 2014, 2015, 2016, and 2017 April and September, it was observed that the water level in Yazıkonak well decreased less than the water level in the Yurtbaşı well. The reason for the decrease in the level in the wells is generally thought to be the decreasing rainfall and the increasing water demand due to the increase in population. However, despite the large increase in precipitation, especially in 2018, the water level continued to decrease in both wells. So much so that in September 2018, the water in the Yazıkonak well was completely exhausted. This is probably because most of the water from precipitation is lost as runoff before it enters the wells.

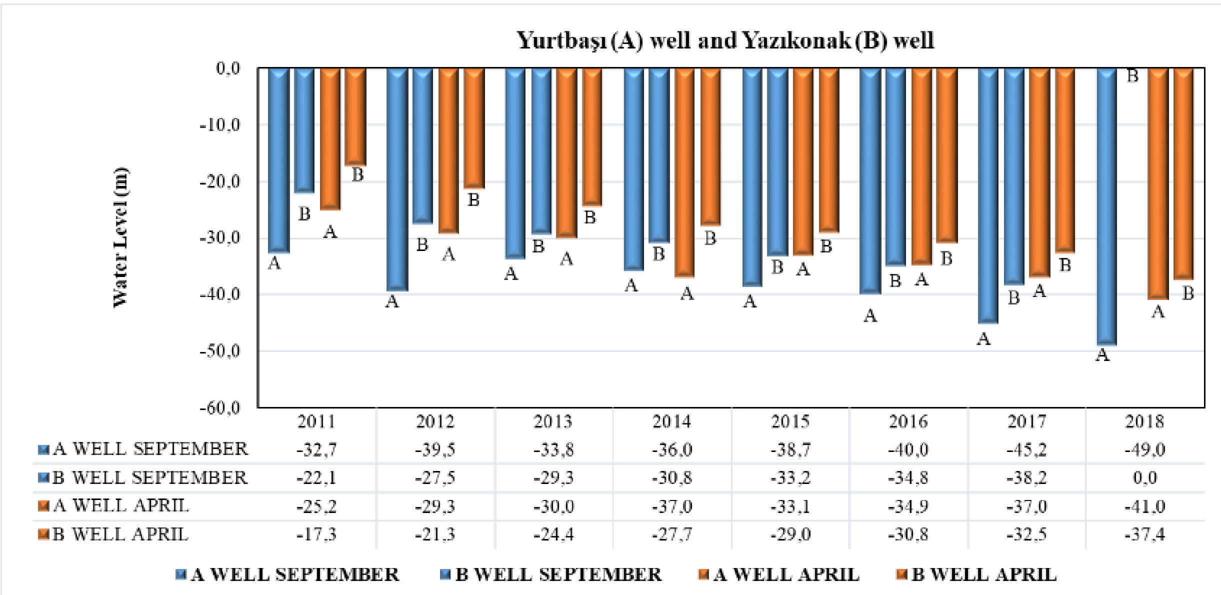

Figure 5. Yurtbaşı and yazıkonak well analysis results

4. DISCUSSION AND CONCLUSION

In the study in which seasonal water level changes and overdraft effect were examined in the period covering the years 2011-2018, the following issues were determined in the Yurtbaşı and Yazıkonak observation wells.

- It was observed that the overdraft was effective in both wells in the relevant time period.
- It has been determined that the seasonal water height changes at Yurtbaşı well are more striking in the other 7 years except for 2018.
- In both observation wells, it was observed that groundwater levels dropped significantly in September, the end of the dry period.
- It was observed that the water level in the Yurtbaşı observation well decreased more than the water level in the Yazıkonak observation well in April and September of all years.
- According to the water level values, it can be said that the overdraft effect in the Yurtbaşı observation well is more pronounced than in the Yazıkonak observation well.
- It was observed that the water height in Yazıkonak well decreased less than the set height in the Yurtbaşı well in both April and September of 2011,2012,2013,2014,2015,2016 and 2017.
- The decrease in water level has negative effects on agricultural and urban (rural) water use.
- It is suggested that global warming and drought in the region also have a significant share in the decrease in the water level in both observation wells.
- Increasing water demands every day also contribute significantly to the reduction of the water level in both observation wells over the years.
- As a result, it was clearly seen that the water level in both wells decreased every year compared to the previous year and was exposed to the overdraft effect.
- In future studies, it would be useful to include other underground observation wells in the basin and conduct a more detailed and comprehensive examination so that the results can be understood more clearly and their true dimensions can be seen. It is thought that it would be useful to create a comprehensive hydro-economic model for this.

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