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Sustainability and Challenges of Water Occupancy Rates of İmranlı Dam Lake in the Rural Region of Sivas Province, Türkiye

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ABSTRACT

Studies on water occupancy rates have an important share in the sustainability of dam lakes, which are an important component of aquatic ecosystems. İmranlı Dam Lake was built between 1994-2002 for energy and agricultural irrigation purposes. This study is about the water occupancy rates of the İmranlı Dam Lake, located in Sivas province of Türkiye, between the years 2010-2021. The highest water occupancy rate of İmranlı Dam Lake was determined as 76.20 percent in 2018, while the lowest water occupancy rate was 27.70% in 2012. The average annual water occupancy rate of İmranlı Dam Lake between 2010-2021 was calculated as 56.86 percent. According to these values, it was determined that the water occupancy rates of the İmranlı Dam Lake did not face a significant decrease between the years 2010-2021. As a result, there is no short-term problem in terms of water occupancy rates in İmranlı Dam Lake. However, this does not mean that it will not be a problem in the long run. For this reason, taking into account the possible effects of climate change (CC), the water of İmranlı Dam Lake should be used sparingly and consciously. As a result of all these measures that can be taken, sustainability will be ensured in the İmranlı Dam Lake, and at the same time, water scarcity will be prevented, the continuity of aquatic vitality will be ensured and losses will be prevented.

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Introduction

Global climate variability is directly related to hydrology and the availability of water resources in the world and has a great importance. As a natural consequence of the increase in greenhouse gases in the atmosphere, changes in temperature, evaporation, air and soil moisture and precipitation regimes affect the hydrological process, the condition of water resources, agriculture, mining, hydroenergy activities, aquatic and land life. CC change accelerates the global hydrological cycle with the increase in surface temperatures, changes in precipitation regime and evaporation rate. Changes in the amount, intensity and frequency of precipitation will affect the amount and frequency of rivers, and flood and drought events that cause significant effects on water resources on a local and regional scale will be experienced. With the decrease in the amount of precipitation and the increase in evaporation, the decreasing amount of runoff threatens the water resources needed for human and industrial activities (Adiller, 2014). Lakes are critical natural resources sensitive to CC. The water cycle is dynamic and naturally variable. Societies and ecosystems continue their lives within this variability. However, CC poses risks on a global scale, especially for lakes that are freshwater sources, and threatens the sustainability of lakes, by changing the water cycle in various ways on different time scales and geographical areas. Risk management is very important for estimating when and how these risks will materialize, and the estimation of the losses that will occur in case of realization. In this context, by developing resilience strategies against anthropogenic climatic events, increasing the lake ecosystem's ability to cope with this threat and adapt to new situations; It is very important for the sustainability of lakes (Işıldar and Ercoşkun, 2021).

With the world population increasing day by day, the importance of water storage is increasing within the framework of more effective and efficient use of water resources, which are decreasing in parallel with industrial and technological developments. Dam lakes are aquatic ecosystem areas built by humans that allow natural environments to be operated by humans. These ecosystem environments offer many natural and human opportunities and they continue to exist with these opportunities

(drinking and irrigation water, energy production, aquaculture, flood management, tourism and leisure activities). Dams are built to control water in many river basins (Atayeter et al. 2022). Dam lakes provide socio-economic and environmental benefits in rural areas. Bringing irrigation and hydroelectric energy projects, which are the most important pillars of sustainable development, to the country's economy is possible with the rational planning and management of the owned water resources.

Türkiye is located in one of the most problematic regions of the world in terms of water resources. Apart from the existing water resources being under threat, it is possible that the existing water resources will not be able to meet the needs with the increasing population. It is obvious that the years 2030-2080 will be years of serious and important water problems due to global warming and CC, which are among the most important problems of the world agenda. In addition to the rapidly increasing need for water throughout Türkiye, the fact that in Türkiye rainfall tends to decrease can be considered a sign in terms of water problems that will arise in the near future. The most distinctive feature of the drought is the scarcity of precipitation and the inability to use the available water consciously and to operate it healthily (Gerek et al. 2008). For this reason, the water occupancy rates of the dam lakes, which are the water collection areas in the future of global CC, are important in terms of the sustainability of water resources, alternative planning and operation. This study was carried out in line with this idea. In this study, it was aimed to investigate the water occupancy rates of the İmranlı Dam Lake, one of the important artificial water resources in Sivas province of Türkiye, between the years 2010-2021.

Materials and Methods

İmranlı Dam Lake is located within the borders of İmranlı district of Sivas Province in Türkiye. It is approximately 110 kilometers from Sivas city center. İmranlı Dam Lake is approximately 2 kilometers from İmranlı town center. Some technical information of İmranlı Dam Lake is summarized in Table 1. İmranlı Dam Lake was built on the Kızılırmak River in Sivas between 1994-2002 for irrigation and energy generation. The height of the dam, which is an earth body fill type, from the river bed is 49.00 meters and the lake area at normal water level is 6.50 square kilometers (Table 1). İmranlı Dam Lake provides irrigation service to an agricultural area of 11220 hectares (URL-1, 2022).

The distrcit of İmranlı, which bears the same name as the İmranlı Dam Lake, is in the east of Sivas province and has a height of 1650 meters from the sea. İmranlı has a mountainous structure compared to Sivas province in general. The land is generally steppe and consists of hills. The area suitable for agriculture is 12700 hectares and the total forest area is 4635 hectares. The mountains descend in an inclined manner towards the Kızılırmak Valley from the north and south. Kızıldağ Mountain, located in the northeast of İmranlı, is the highest mountain of Sivas province with its height of 3025 meters and is located at the intersection of Central Anatolia, Eastern Anatolia and Black Sea Regions. Kızıldağ Mountain is also the birth place of Kızılırmak River. The river is the longest river of our country, which originates within the borders of Türkiye and empties into the sea again within the territory of Türkiye, with a length of 1151 kilometers. It arises from the southern slopes of Kızıldağ Mountain in the east of İmranlı in three branches. These three branches converge near Çukuryurt village, 6 kilometers away from İmranlı district, and merge into İmranlı Dam Lake, taking the name Kızılırmak River. Since the waters of İmranlı Dam Lake are close to the source, they are cold, clean and clear (Dirican, 2022a). İmranlı is a mountainous district dominated by a continental climate with hot, dry and windy summers and cold winters. The number of summer days is 78 days. The total annual precipitation in İmranlı is 412 mm (Yıldırım, 2018). The coldest place in Sivas is İmranlı. The average temperature of İmranlı in winter is below zero degrees Celsius. Therefore, the surface of İmranlı Dam Lake freezes in winter.

In this study, water occupancy rate data between 2010 and 2021 obtained from the General Directorate of State Hydraulic Works in Türkiye for İmranlı Dam Lake were used. The occupancy rate includes the data of the monitored dams (with an active water volume of 3 million cubic meters and above). The changes in the water occupancy rates and sustainability of the İmranlı Dam Lake between the years 2010-2021 were examined with these data. The changes in the water occupancy rates of İmranlı Dam Lake were analyzed and synthesized in accordance with the purpose of the study. Occupancy rate of İmranlı Dam Lake was calculated as the ratio of active dam volume to total active dam volume. The occupancy rate of İmranlı Dam Lake is expressed in percent (%).

Table 1. Some technical information about İmranlı Dam Lake.

N	Features	Value
1	Country	Türkiye
2	Province	Sivas
3	Build Start Year	1994
4	Build Completion Year	2002
5	Goal of the Dam	Energy, Irrigation
6	River	Kzılırmak River
7	Body Fill Type	Soil
8	Height	49.00 m
9	Lake Volume	62.50 hm^3
10	Lake Area	6.50 km^2
11	Irrigation Area Gross	11.220 ha

Results and Discussion

The water occupancy rates of İmranlı Dam Lake show a tendency to fluctuate in a narrow area between 2010-2021 (Figure 1). The water occupancy rate of the İmranlı Dam Lake in 2010 was determined as 52.94 percent. In 2011 and 2012, the water occupancy rate decreased to 43.62 percent and 27.70 percent, respectively. In 2013 and 2014, the water occupancy rate increased to 29.50 percent and 73.10 percent, respectively. In 2015, the water occupancy rate decreased to 58.60 percent. In 2016, the water occupancy rate increased to 73.00 percent. In 2017, the water occupancy rate decreased to 64.70 percent.

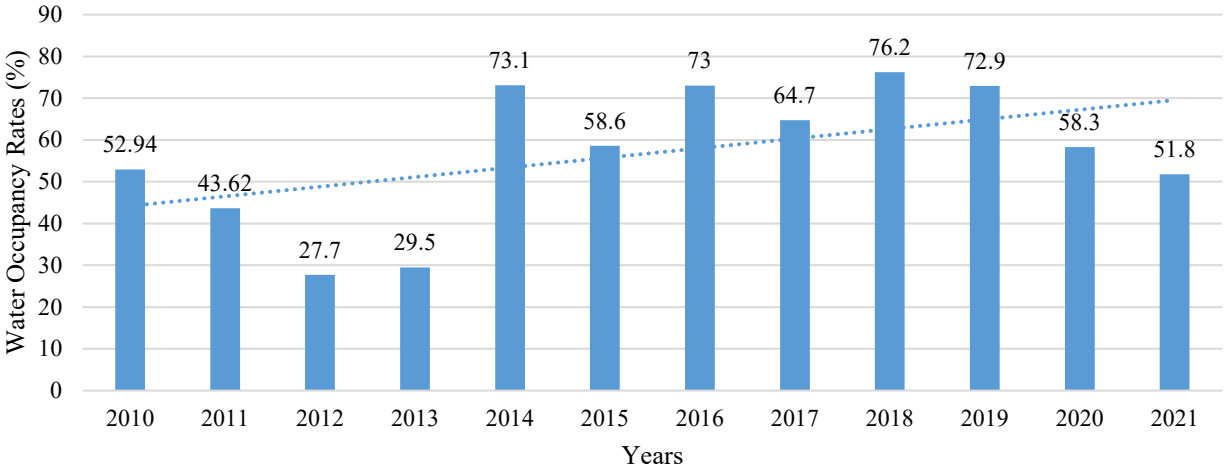

Figure 1. Changes in the water occupancy rates of İmranlı Dam Lake between 2010-2021

In 2018, the water occupancy rate increased to 76.20 percent. In 2019, 2020 and 2021, the water occupancy rate decreased to 72.90 percent, 27.70 percent and 51.80 percent, respectively (Figure 1). While the lowest water occupancy rate of İmranlı Dam Lake was observed in 2012 with 27.70%, the highest water occupancy rate was observed in 2018 with 76.20%. The average water occupancy rate of the İmranlı Dam Lake between 2010-2021 was calculated as 56.86±16.62 percent. Accordingly, it can be said that the water occupancy rates of İmranlı Dam Lake are in good condition.

While the water occupancy rate of the İmranlı Dam Lake was below the 50 percent band in 2010-2013, the water occupancy rate was above the 50 percent band in 2014-2021 (Figure 1). Water resources are of great importance for both society and ecosystem. Human beings and all other living things on Earth need clean water resources in order to sustain their lives in a healthy way. In addition, water is needed for agriculture, energy production, recreation and various production activities. This situation puts pressure on water resources and causes concern about the gradual decrease of available resources due to CC. In many areas, it is possible that CC will double its negative effects by increasing the need for water on the one hand and reducing water resources on the other (Adiller, 2014). İmranlı Dam Lake has first class water quality and the annual average nitrate value is 1.5 mg/L (SEP, 2021). According to TWPCR (2008), the water of the İmranlı Dam Lake, which has first class water quality, can be disinfected and used not only for drinking purposes, but also for recreational purposes, rainbow trout farming, animal production and other purposes. Therefore, İmranlı Dam Lake is an important water source for the region and Türkiye. İmranlı Dam Lake was opened for fish farming in 2010, and there is one farm in this area that produces rainbow trout in 42 net cages designed by the Sivas Agriculture and Forestry Provincial Directorate. This farm, which produces rainbow trout in İmranlı Dam Lake, has an annual production capacity of 950 tons (Dirican, 2022a). Fish species such as barbel, bleak, carp, chub, freshwater perch, khramulya and rainbow trout live in İmranlı Dam Lake. For this reason, angling is also carried out in the İmranlı Dam Lake (Dirican, 2022a). The fishing rights of the hunting area of İmranlı Dam Lake were leased from 17.08.2021 to 16.08.2026. However, one boat was licensed for fishing in the İmranlı Dam Lake (Dirican, 2022b). İmranlı Dam Lake is an important water source where economic activities such as rainbow trout farming in cages, angling and commercial fishing are carried out as well as energy and agricultural irrigation.

With this study, it has been determined that approximately 50 percent of the İmranlı Dam Lake is full, according to the water occupancy rates between the years 2010-2021. According to the water occupancy rates of the last twelve years in İmranlı Dam Lake, it has been determined that the slope line is also upwards (Figure 1). In this case, it indicates that the water occupancy rates of the İmranlı Dam Lake are at a good level. Therefore, it can be said that the water occupancy rates for energy, agricultural irrigation, rainbow trout farming in cages, angling and commercial fishing are close to normal levels in İmranlı Dam Lake. For now, it can be said that there is no risk for the İmranlı Dam Lake in the short term in terms of energy, agricultural irrigation, rainbow trout farming in cages, angling and commercial fishing.

In recent years, one of the most important issues on the world agenda is global CC. It is estimated that there will be increases in temperatures in latitudes, including Türkiye, as well as decreases in precipitation and soil water content. According to studies conducted with global climate models, a large part of Türkiye will be under the influence of a very dry and hot climate in 2030. Temperatures in Türkiye will increase by 2 ºC in winter and 2-3 ºC in summer. While precipitation will decrease by 5-15% in summer, there will be a slight increase in winter (Gerek et al. 2008). A large part of Türkiye is under the influence of arid and semi-arid climate, and there is a serious water shortage, especially in summer. In countries where these problems are experienced, it is an inevitable fact that dam constructions are needed for the efficient use of water, taking into account the sustainability of resources and the economic development of the country (Engindeniz et al. 2014). According to these, the effects of drought will be felt more in the future in Türkiye, which is arid and semi-arid, and the importance of water will increase for Türkiye in the future. For these reasons, it is very important to investigate the water occupancy rates of the İmranlı Dam Lake in terms of the planning, operation and management

of water resources. Considering the possible effects of CC, it is necessary for the country's economy to develop, revise, and use water resources sparingly and consciously. As long as we continue to use the İmranlı Dam Lake correctly and sparingly, take precautions and comply with the necessary legal regulations, it will continue to maintain its continuity in the living things in its waters and the vitality connected to this food chain. The most important step of CC is to protect our waters and the creatures in it and to ensure the continuity of life. As a result of drought, the greatest vital problem that we will face will arise with the danger of being without water and food. The world, water and living things should be protected and precautions should be taken. Laws should be revised and even new ones should be enacted, training should be given due importance and climate crisis awareness should be created. After that, all precautions should be taken in this direction. With the aim of meeting the needs of the present without preventing future generations from meeting their needs, the necessary adaptation, mitigation and combating methods against CC should be jointly developed in accordance with local locations and practices that can sustain sustainable development should be given priority. Freshwater ecosystems and dam lakes enable many people living in rural areas to continue their lives, making it possible for every society to reach very valuable goods and services. If water resources are not managed effectively and competently, environmental problems may arise due to their depletion.

Conclusion

In this study, it was observed that the water occupancy rate of the İmranlı Dam Lake between the years 2010-2021 was good. However, it was determined that the water occupancy rate, which was 76.20 percent in 2018, decreased to 72.90 percent in 2019, 58.30 percent in 2020 and 51.80 percent in 2021 for İmranlı Dam Lake. It has been determined that the water occupancy rates of the İmranlı Dam Lake are generally in good condition in the short term between 2010-2021 with this study. With the emergence of the effects of CC on human activities depending on location and time, social, economic, industry, agriculture, forest, water resources and the like in countries are affected, and it is inevitable that if greenhouse gas emissions are not prevented in the coming years, there will be increasing effects. The multidimensional and comprehensive potential impact power of CC makes the solution of this problem dependent on the development of environmental awareness, solidarity and cooperation around the world. Therefore, one of the prerequisites for coping with CC is to take measures to develop positive attitudes and behaviors to increase awareness levels.

Declarations

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