

A Study on Reservoirs and Intended Purposes in Suşehri, Sivas, Turkey

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Abstract

A reservoir is defined as an open air storage area where water is collected and kept in quantity so that it may be drawn off for use. Reservoirs have important functions such as collecting water, raising water level and creating large water surface. Reservoirs are significant hydrologic properties affecting numerous aspects of the aquatic ecosystem. This study was carried out to determine the intended purposes of reservoirs in Suşehri. The region is named as Suşehri due to its richness in terms of water resources. There are two reservoirs in Suşehri, which are Kılıçkaya Reservoir and Çamlığöze Reservoir on the Kelkit Stream. These reservoirs have a wide variety of purposes and functions. They are intended to use in hydroelectric energy production and rainbow trout culture occupies an important place in Suşehri. Natural resource management requires a holistic approach to Kılıçkaya and Çamlığöze Reservoirs of ecosystems.

Keywords

Environment; Reservoir; Water; Sustainable energy

Introduction

Water is the vital resource to support all forms of life on earth. Sustainable development of water is considerably important as in all of the World and Turkey. Sustainable development requires attention to a wide range of economical, social and environmental objectives. Water and energy for sustainable development depends not only on supply choices, but also on how these choices are implemented. The intent for multipurpose water uses of hydropower reservoirs is to ensure that positive aspects are maximized and negative impacts avoided, minimized, mitigated or compensated.

The production and use of energy and the storage and use of water are vital to the health and welfare of all nations, and the wise stewardship of these resources is essential to the protection of the environment. Water and energy are inextricably linked and the provision of clean and abundant

sources of water depends on the availability of clean, affordable and sustainable energy [1]. Reservoir is generally functioned as storage. It is used for raising the water level and has the dam body as a barrier to seepage of water downstream and as a buffer for water storage. If the reservoir has multipurpose functions such as water supply, drinking water, hydro-electrical power, irrigation, fisheries, aquaculture, navigation, recreation, firefighting, drought management, flood and sedimentation control, we can imagine how important the function of the reservoir for human life is [2].

Turkey is situated between Europe and Asia. Turkey has very rich water resource potential in both marine and inland waters with 8333 km of coastline, 175000 km of rivers, 1000000 ha of natural lakes, 170000 ha of reservoirs, and 700 small reservoirs used for local needs such as irrigation and the contribution to drinking water [3-5]. Reservoirs can have many functions of the economic and natural character. If they are designed and constructed properly they can be a valuable element of the natural landscape in rural areas. Reservoirs improve the structure of water resources and increase biodiversity in areas used by humans while they can be used for commercial purposes at the same time [6]. This study is focused the intended purposes of reservoirs in Suşehri which was located in rural area.

Materials and Methods

Study area

The study area included two reservoirs, Kılıçkaya and Çamlığöze Reservoirs on Kelkit Stream, a tributary of the Yeşilirmak River which flows down along a large fault in the north east Anatolia than runs into the Black Sea. Kelkit Stream, one of the three main branches of the Yeşilirmak River, drains the northeast part of the Yeşilirmak Basin and contributes 55% of Yeşilirmak River annual flow. Kelkit Stream is formed by joining together of small streams that originate from Spikor, Pular, Otlukbeli, Sarhan and Balaban mountains, located in the north Erzincan, near the Kelkit district. It passes through Suşehri, Niksar and Erbaa plains and then joins to Yeşilirmak River in the north of Erbaa plain. Kelkit Stream is 245.5 km in length and its watershed area is 11455 km². The major land uses in the basin are agriculture (36%) and forests (38%), with the remaining areas being developed areas, wetlands and

open water. The land rises from an altitude of 188-1460 m in the watershed.

Kelkit Stream watershed is located on the north Anatolia fault line that is one of the most effective faults in the world. Since the watershed is formed under Hercynian, alpine progeny and epirogeny movement, the rock formations on the watershed have a broken and curled structure. The rock formation as sandstone, claystone, granite, andesite, basalt, volcanic breccia and tuff are common in the area [7,8].

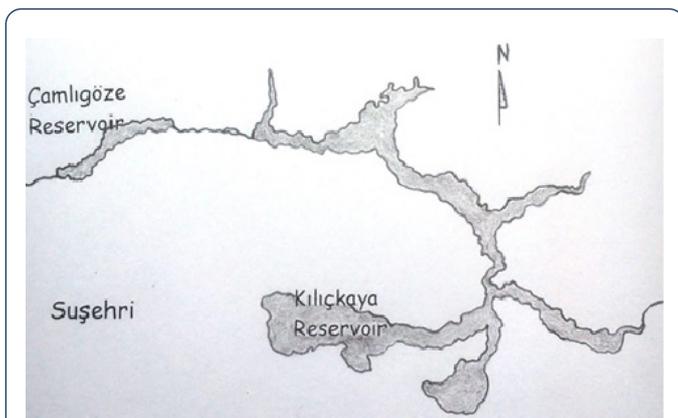


Figure 1 Location of Kılıçkaya and Çamlığöze reservoirs.

Çamlığöze Reservoir is located in just below of the Kılıçkaya Reservoir on the Kelkit Stream. The location of Kılıçkaya and Çamlığöze Reservoirs is shown in **Figure 1**. Kılıçkaya and Çamlığöze Reservoirs have been constructed in Suşehri, Sivas, Turkey. The province of Sivas is located at the eastern part of the Central Anatolian region of Turkey. The majority of Sivas shares the climate of terrestrial in which the summer seasons are hot and dry while winter seasons are cold and snowy. However, the northern part of the Sivas shares the Black Sea climate [9]. Suşehri is situated in the east of Sivas about 140 km the province centre. Suşehri where altitude is 950 m has settled on an area of 985 km². Suşehri is located in a rural area. In the town which has been named as Suşehri because of the bounty of water in the region [10]. Suşehri has a rich potential with respect to nature tourism activities thanks to its natural and human-made attractions owned.

Data collection and analysis

This study was performed in Suşehri between September 2014 and October 2016. The study was supported with fieldwork that took place over a period of two years. Data used in the study were collected with a cultural ecological perspective during this fieldwork. The study was prepared in the light of survey and interview in the field. Socio-ecologic interview and participant observation methods were used to understand every season in study area.

Results and Discussion

There are two reservoirs in Suşehri, which are Kılıçkaya Reservoir and Çamlığöze Reservoir on the Kelkit Stream.

Kılıçkaya and Çamlığöze Reservoirs are located in Suşehri, Sivas, Turkey. There are different purposes of reservoirs in Suşehri. Some technical characteristics of Kılıçkaya and Çamlığöze Reservoirs are given in **Table 1**. Kılıçkaya Reservoir is located 25 km north of town of Suşehri 158 km northeast of Sivas province in Turkey.

Geographical coordinates of Kılıçkaya Reservoir are 40° 14' 0" N, 38° 11' 0" E. The Kılıçkaya Dam was constructed between 1980 and 1989 on the Kelkit Stream. Kılıçkaya Dam is a 132 m high rockfill a power plant. The surface area and maximum depth of the Kılıçkaya Reservoir are 64.4 km² and 100 m respectively. Average annual capacity of Kılıçkaya Hydroelectric Station is 332 GWh (**Table 1**). The water of Kılıçkaya Reservoir is mainly used for producing electrical energy, commercial fishing, irrigation and recreation.

Kılıçkaya Reservoir is contributing significantly for agricultural irrigation. A fish passage is not located on Kılıçkaya Reservoir. The commercial catch were presented by eight fish species and majority of them were European catfish and carp in Kılıçkaya Reservoir. Fishing is carried out with set nets, fyke nets, seine nets, various types of fishing lines and local traps. In the present study, it was found that the most of fishing gears used in this region were monofilament gillnets. Average length of fishing boats used ranged from 3 to 12 m and all of them are motorized.

Most of the people, who were fishing activity in the reservoir, haven't license of amateur or professional fisherman while the Kılıçkaya Reservoir has provided important income for the people. These fishing activities in Kılıçkaya Reservoir were determined artisanal fishing. Kılıçkaya Reservoir for the capture fisheries has been rented. Kılıçkaya Reservoir, energy production, as well as income generating activities such as fishing have brought vitality to the local economy. Kılıçkaya Reservoir, aquaculture is not engaged in any fish farm. Because, water temperature and dissolved oxygen of Kılıçkaya Reservoir are not very convenient for aquaculture of rainbow trout in summer season.

Çamlığöze Reservoir, 12 km downstream of the Kılıçkaya Reservoir is located on the Kelkit Stream. Çamlığöze Reservoir is located 11 km north of town of Suşehri 140 km northeast of Sivas province in Turkey. Geographical coordinates of Çamlığöze Reservoir are 40° 13' 45" N, 38° 04' 36" E. The Çamlığöze Dam was constructed between 1987 and 1998 on the Kelkit Stream. Çamlığöze Dam is a 37 m high rockfill a power plant.

The surface area and maximum depth of the Çamlığöze Reservoir are 5 km² and 30 m respectively. Average annual capacity of Çamlığöze Hydroelectric Station is 102 GWh (**Table 1**). A fish passage is not located on Çamlığöze Reservoir. Çamlığöze Reservoir is fed by water coming from the Kılıçkaya Reservoir. Another important resource is not available except for Kılıçkaya Reservoir. Çamlığöze Reservoir waters, Kılıçkaya Reservoir come from the depths of the waters and a short distance between the two reservoirs because the reservoir is a

little bit colder. The water of Çamlığöze Reservoir is colder than Kılıçkaya Reservoir.

Table 1 Some technical characteristics of Kılıçkaya and Çamlığöze reservoirs in Suşehri.

Technical Characteristics	Kılıçkaya Reservoir	Çamlığöze Reservoir
Construction Starting Year	1980	1987
Construction Year	1989	1998
Completion Year		
Start Up Date Year	1990	1998
Age	28	20
Embankment Type	Rock fill	Rock fill
Normal Reservoir Volume (hm ³)	1400	50
Height From Stream Bed (m)	134	38
Crest Elevation (m)	855	755
Crest Length (m)	360	405
Surface Area (km ²)	64.4	5
Maximum Depth (m)	100	30
Capacity (MW)	124	33
Annual Generation (GWh)	332	102

The water of Çamlığöze Reservoir is mainly used for produce electrical energy, commercial fishing, aquaculture, irrigation and recreation. Çamlığöze Reservoir is contributing significantly for agricultural irrigation. The commercial catch was presented by nine fish species and majority of them were European catfish, carp and rainbow trout in Çamlığöze Reservoir. Fishing is carried out with set nets, fyke nets, seine nets, various types of fishing lines and local traps in Çamlığöze Reservoir. It was found that the most of fishing gears used in this region were monofilament gillnets in Çamlığöze Reservoir. Average length of fishing boats used ranged from 3 to 6 m and all of them are motorized. Most of the people, who were fishing activity in the reservoir, have not license of amateur or professional fisherman while the Çamlığöze Reservoir has provided important income for the people. These fishing activities in Çamlığöze Reservoir were determined artisanal fishing. Çamlığöze Reservoir, energy production, as well as income-generating activities such as fishing and rainbow trout culture has brought vitality to the local economy in Suşehri. The rainbow trout culture is done in Çamlığöze Reservoir. At about 3% of Çamlığöz Reservoir trout farming is made in cages. The area outside of the cage culture for the capture fisheries has been rented in Çamlığöze Reservoir. Ecological and natural conditions of Çamlığöze Reservoir are very convenient for aquaculture of rainbow trout. Only five fish farms are present in Çamlığöze Reservoir and their annual total production capacity is about 4250 tons in project base. Rainbow trout is the most dominant fish species for aquaculture in Turkey. Commercial rainbow trout farming started in Turkey in 1971 and it has increased dramatically afterwards. In 1986, 990 tons

of rainbow trout was produced in Turkey [11,12]. The production level reached 101166 tons according to the data in 2016 [13]. A total of 4250 tons of rainbow trout are produced in 5 farms in Çamlığöze Reservoir in cages. This production amount is 4.20% of the total rainbow trout production in Turkey. These fish farms are made in cages as intensive aquaculture in Çamlığöze Reservoir. Aquaculture is an activity that has many interactions with the surrounding environment using resources and producing changes in the ecological system. Development of aquaculture industry generates profit and income, but it also bears risks of negative environmental impacts which are discharge of untreated wastes into coastal waters, landscape modification, harmful genetic interactions with wild fish, transfer of parasites and diseases, displacement of wild fish populations, use of chemical and antibiotics or biodiversity change [14-16]. The goal of aquaculture is grow in a manner that does not harm to aquatic ecosystems. Therefore in particularly, monitoring of environmental impacts of aquaculture is very important for aquatic ecosystems conservation in Çamlığöze Reservoir.

Kılıçkaya and Çamlığöze Reservoirs energy, fisheries, irrigation and recreation are very purposeful. A total of 370 hydroelectric power plants in Turkey's average annual energy production is 70734 GWh [17]. A total of 434 GWh of annual energy production is produced in Kılıçkaya and Çamlığöze Hydroelectric Power Plants (Table 1). This annual energy production amount is 0.61% of the total annual hydroelectric energy production in Turkey.

Kılıçkaya and Çamlığöze Reservoirs formed behind the dam, has created new tourism opportunities. Reservoir surroundings are in great demand by the local people. People tend to prefer this reservoir area for natural beauty, wonderful views, fresh air and nature walks. Especially, water sports as swimming, water skiing, boating, surfing and fishing are developed in Kılıçkaya Reservoir. These activities are very important for a small town Suşehri. Made in the reservoirs of freshwater fishing, an activity is very good for enthusiasts. The amateur fishing is done in Kılıçkaya and Çamlığöze Reservoirs. Reservoirs are artificial lakes where fish life should be able to develop as in natural lakes and provide an abundant source of food for lakeside populations as well as opportunities for recreational fishing. Kılıçkaya and Çamlığöze Reservoirs like some other reservoirs have even become well known in this respect. Determining sustainable management strategies of Kılıçkaya and Çamlığöze Reservoirs of fisheries is important for the efficient water resources usage within the frame of aquaculture and fisheries. Protection of biodiversity, ecosystem and human health sensitivity should be considered throughout of this determination process. As a result, the fishermen should be informed by new fisheries knowledge and much more modern fisheries technic should be applied in the reservoir to obtain sustainable yield from Kılıçkaya and Çamlığöze Reservoirs in Suşehri. It has been determined that there is no water pollution in Kılıçkaya and Çamlığöze Reservoirs but there are lack of landscaping arrangements, afforestation and picnic areas. Kılıçkaya and Çamlığöze Reservoirs were not showed any significant water pollution problem during the study period. This situation can be linked

to Kılıçkaya and Çamlığöze Reservoirs with remote from industry regions. These reservoirs seem to have a high touristic potential, and the natural facilities to be built in the reservoir surroundings and the functions of these artificial lakes should be increased under the prefecture governorship and municipality in Suşehri. In addition, together with these facilities, the introduction of reservoirs will increase the availability of these areas and the internal and external tourism will be provided these natural places. In this way, settlement around the reservoir will have an important source in raising the development threshold. Moreover, awareness creation among policy makers and beneficiaries is also essential to attain a sustainable land and water management in Suşehri.

Conclusion

Kılıçkaya and Çamlığöze Reservoirs are valuable elements of rural landscape. They are a valuable part of both agricultural and landscape. The observations and fieldwork made on these two reservoirs and results show that the reservoirs have deficiencies such as landscape arrangements and environmental management. Natural resource management requires a holistic approach to Kılıçkaya and Çamlığöze Reservoirs of resources and ecosystems. The goal for a nation is to achieve clean and healthy reservoirs which support aquatic life as well as their economic development and human needs. This goal is best met by encouraging and supporting comprehensive water resource management that is tailored to the regional and local needs. However, further research is needed on the selection of the appropriate water management. A continuous monitoring program of the Kılıçkaya and Çamlığöze reservoirs will provide rather useful knowledge for environmental management in Suşehri.

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