Alınteri Journal of Agricultural Sciences. 2017, 32(1): 81-89
Alınteri Zirai Bilimler Dergisi

Determining The Water Quality of Maruf Dam (Boyabat–Sinop)

Research / Araştırma

Received / Geliş Tarihi
18.06.2017

Accepted / Kabul Tarih
28.06.2017

DOI
10.28955/alinterizbd.322252

ISSN 2564-7814
e-ISSN 2587-2249

Ekrem MUTLU[1]*, Banu KUTLU[2]

[1] *Kastamonu University, Faculty of Fisheries, Department of Aquaculture, Kastamonu- Turkey*
[2] *Tunceli University, Faculty of Fisheries, Department of Fundamental Sciences, Tunceli- Turkey*

****e-posta:** ekrem-mutlu@hotmail.com*

Abstract: In this study, the preliminary findings obtained from 3 sampling points, which represent the whole, on Maruf Irrigation Dam, which is located in Boyabat district of Sinop province, for 12 months between September 2015 and August 2016 were examined. The parameters monitored are temperature, dissolved oxygen, pH, electrical conductivity, total hardness, total alkalinity, chemical oxygen demand, biological oxygen demand, and dissolved anions and cations (sodium, potassium, calcium, magnesium, ammonium, nitrate, phosphate, chloride, sulfate, and sulfite). Because of its low dissolved ionic matter content, Maruf Dam was characterized as an alkali dam with mid-hard water and low electrical conductivity. In terms of parameters A and B of Surface Water Quality Management Regulation, the dam is considered “high-quality” and “unpolluted”. Besides the irrigation purposes, for which the barrage was constructed, the dam can also be used for aquaculture, animal breeding, and farming needs.

Keywords: Water quality, water pollution, Sinop, Maruf Dam

Maruf Göleti’nin (Boyabat–Sinop) Su Kalitesinin Belirlenmesi

Öz: Bu çalışmada; Sinop ili Boyabat ilçesinde bulunan Maruf Sulama Baraj Göleti'nin bütününü temsil eden üç noktadan alınan su örneklerinin Eylül 2015 ile Ağustos 2016 arasında 12 ay süresince su kalitesi izleme araştırmasından elde edilen ilk bulguları değerlendirilmiştir. Araştırma süresince; sıcaklık, çözünmüş oksijen, pH, elektriksel iletkenlik, toplam sertlik, toplam alkalinite, kimyasal oksijen ihtiyacı, biyolojik oksijen ihtiyacı çözünmüş anyon ve katyonlar (sodyum, potasyum, kalsiyum, magnezyum, amonyum, nitrat, fosfat, klorür, sülfat ve sülfit) ile izlenmiştir. Maruf Gölü düşük çözünmüş iyonik madde içeriğini nedeniyle düşük elektriksel iletkenlik ve çözünmüş katı madde içeriğine sahip orta sert sulu alkali bir göl olarak karakterize olmuştur. Yüzeysel Su Kalitesi Yönetimi Yönetmeliği A ve B grubu parametreleri bakımından baraj gölü “yüksek kaliteli” ve “kirlenmemiş” sınıflarına dâhil olmuştur. Baraj gölünün inşa amacı olan tarımsal sulama yanı, alabalık ve diğer balıkların yetiştiriciliği ile hayvan üretimi ve çiftlik ihtiyacı için de kullanılabileceği sonucuna ulaşılmıştır.

Anahtar Kelimeler: Su kalitesi, su kirliliği, Sinop, Maruf Göleti

1. INTRODUCTION

The wetland areas, which are very important for all the creatures living around them, have an important place among the ecological structures. As well as they meet the shelter, reproduction, feeding, habitat, and wintering needs of fauna and flora, the wetland areas also have different functions such as arranging the water flow, feeding the wetlands, protecting the biological diversity, maintaining the fisheries and hunting, tourism, and scientific researches, and they are the natural systems being under threat due to pollution and excessive and unplanned use (Elma et al., 2010). Because of these, they are considered as natural wealth areas of their region (Anonymous, 2007).

The characteristics and locations of barrages, which are one of the most important effects of human on environment, are determined according to the addressed purposes and natural environmental conditions (Koca, 2005). Besides that, the main objective of constructing a barrage is mainly the energy production, as well as obtaining potable, usage, and irrigation water and preventing the overflowing (Doğanay, 1998). Maruf (Sinop) Barrage has been constructed in year 1999 for the irrigation of agricultural lands and obtaining water. The barrage construction gained speed in our country, and both qualitatively and quantitatively large projects have been realized (Orhan, 2015). In general, the barrages, dams, and ponds are constructed for various purposes such as electricity production, obtaining potable water, agricultural irrigation, aquaculture, overflow prevention, and recreation (Mason, 2002). Physicochemical water quality, diversity of aquatic species, and abundance of a dam significantly differs from that of river feeding the pond. For this reason, it is necessary to regularly monitor the natural sources in a newly-constructed barrage dam (Yılmaz 2004). In barrage dams used for obtaining potable water, the compliance to potable water standards is very important and thus it is necessary to monitor the process of ecosystem by using programs for detecting the problems in water quality (Tüzün et al., 2006). In fact, for ensuring the efficient use of a water resource, it is a must to collect information about the resource by carefully carrying out a monitoring program that is capable of meeting the expectations (Şen and Koçer, 2003).

In aquatic environments, the main criteria affecting the pollution are physicochemical and biological factors. Monitoring the creatures living in water is very important from the aspects of biological diversity, water quality, food chain, and biological cleaning of water. It is required to continuously predetermined parameters, to examine the changes, and to determine how these changing parameters will affect the water quality. The increase of nitrogen and phosphor, which exist in domestic and some industrial wastes and agricultural drainage water, exceeding a certain limit causes excessive algae in ponds through photosynthesis and increase in organic matters. This phenomenon, which is characterized with emergence of H_2S, CH_4, NH_3, and etc. gases due to algae bloom, increase turbidity, increase in organic matters and consequently oxygen demand and is named eutrophication, continues for a long time even if the entrance of such nutrients into the water is prevented. The examination of effects on water resource depends on the data obtained from specific monitoring studies examining the physical, chemical, and biological conditions of water. The physical, chemical, and biological characteristics of water resources are very important. There are many studies that have been carried out on this subject in our country (Akkan et al., 2011; Kurnaz et al., 2016; Polat and Akkan, 2016).
In this study, the physicochemical parameters of Maruf Dam were compared to national and international regulation limits and the status of dam was examined as a whole.

2. MATERIAL AND METHODS

This study on Maruf Dam was started on September 2015 and ended on August 2016. 3 sampling stations representing the whole dam were selected. Water samples were monthly collected from these stations. The pond is located in Boyabat district of Sinop province in Kızılırmak Basin. Its surface area is 0.1 km^2, and volume is 100 hak. Water resources of dam are Brook Ekinveren, precipitation waters, and snow waters. Brook Ekinveren follows a long course and pours into Maruf Dam. Maruf Village is a village, which has a significant agricultural potential and located in Boyabat district.
In determining the sampling stations, the points that are capable of homogenously representing the characteristics of dam were preferred.

1st station: western side of dam (B: 34.790660 E: 41.572411; the side of agricultural lands)
2nd station: eastern side (B: 34.794490 E: 41.571729; forest side)
3rd station: entrance of Brook Ekinveren into dam (B: 34. 791738 E: 41. 570677)

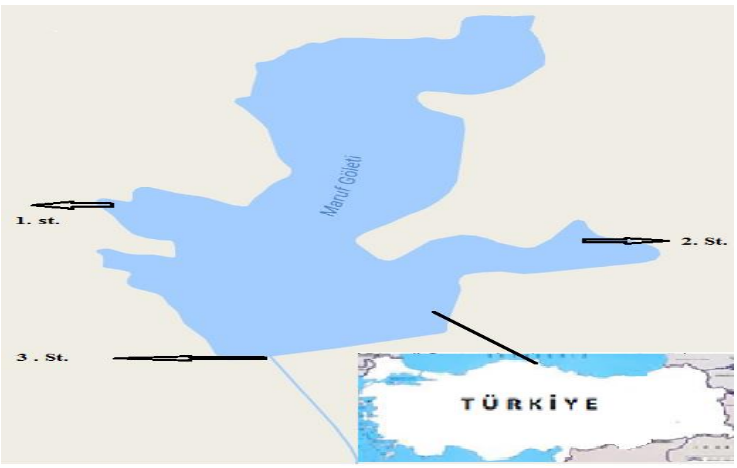

Figure1. Maruf Barrage Dam and sampling points

This study was carried out for 1 year between September 2015 and August 2016. The physical and chemical parameters constituting the water quality were used in analyses. Water samples were taken 15cm below the surface after rinsing the sampling containers with water of dam. Temperature, pH, dissolved oxygen, salinity, and electrical conductivity were measured HACH HQ40D Digital 2-Channel Multiparameter device.

For total alkalinity, total hardness, nitrite, nitrate, ammonium nitrogen, sulfite, sulfate, chloride, sodium, potassium, suspended solid matter (SSM), chemical oxygen demand (COD), calcium, magnesium, lead, ferrous, copper, and cadmium analyses, the water samples were taken to Laboratory of Faculty of Fisheries, Kastamonu University, in max. 5 hours. Titration with sulfuric acid was used for total alkalinity, while titration with EDTA was used for total hardness. The results are expressed in mg/L $CaCO_3$.

Heavy metals in water (ferrous, copper, zinc, nickel, and lead) were measured using Shimadzu GCMS- QP2010 ULTRA gas chromatograph – mass chromatograph in Central Laboratory of Kastamonu University. BOD was measured using HACH LANGE BOD TRAK II Manometric device, while chemical oxygen demand, chloride, phosphate, sulfate, sulfite, potassium, magnesium, calcium, nitrite, nitrate, and ammonium nitrogen were measured using HACH DR 6000 Desktop Spectrophotometer in Laboratory of Faculty of Fisheries, Kastamonu University on the same day.
Suspended solid matter (SSM) analysis was performed by filtering the water through Whatman membrane filters and then keeping the filter papers at 103 °C for 24 hours and calculating the weight difference.

3. RESULTS

The physicochemical properties of water were determined by analyzing the samples taken from sampling points on Maruf Dam for 12 months. In Table 1, the results obtained for 21 parameters are presented as ratio, mean, and standard deviation.

The temperature of surface water is an important variable since the critical temperature is different for different species. Throughout the sampling, Maruf Dam showed the expected seasonal temperature changes, and no significant difference was observed between the stations. pH level higher than 7 indicates the alkali conditions dominating the dam (Karafistan and Arık-Çolakoğlu, 2005). pH values of dam ranged between 7.9 and 8.42. The pH levels higher than 7 originate from possible carbonate and bicarbonate contents. In certain cases, the natural waters might contain significant carbonate and hydroxide alkalinity. This is especially seen in surface waters, where the algae reproduce. Algae use the free and ionized carbon-dioxide in water, and thus they might increase the pH level of water (Şengül and Müezzinoğlu, 2005).
The mean electrical conductivity of surface water was determined to be 201.31±67.18 μS/cm. The maximum electrical conductivity was found in 3rd station to be 280 μS/cm, whereas the minimum one was found in 1st station to be 124.28 μS/cm (Table 1). The monthly changes in electrical conductivity are significant ($p<0.05$). EC values were found to be higher in summer in comparison with spring, autumn, and winter seasons (Tepe, 2009). This generally shows parallelism with the increase in salinity and biological activities (Tugrul and Polat, 1995). The electrical conductivity of water depends on both geological and external factors. As the pollution of water increases, then the electrical conductivity exceeds beyond 1000 μS/cm. The value found in Maruf Dam is much less than this limit. The electrical conductivity varies depending on the geological structure and precipitation level, while it is not affected from the nutrients in water (Temponeras et al., 2000).

The level of dissolved oxygen in water is of vital importance for the esthetical quality of water and aquatic life (Dişli et al., 2005). As seen in Table 1, the mean dissolved oxygen level of Maruf Dam varies between 9 and 12 mg/L. The dissolved oxygen levels naturally increase in winter, whereas they decrease in summer season. Accordingly, it can be stated that Maruf Dam is suitable for aquatic life in terms of dissolved oxygen level. According to Water Pollution Control Regulation, the waters with dissolved oxygen level of 8 mg/L are considered high-quality, while those with dissolved oxygen level of 6 mg/L to be Class II, those with dissolved oxygen level of 3 mg/L to be Class III, and <3 mg/L to be Class IV polluted water. According to Water Pollution Control Regulation, Maruf Dam is in Class I.

Biological oxygen demand (BOD) is a parameter considered to be a general measure of the effect of organic pollution on receiver waters. High BOD value of Maruf Dam (2.19±0.54 mg/L) indicates that there is no organic pollution load on the dam (Usha et al., 2006). Moreover, high BOD concentrations might be dangerous when the saturated oxygen values decrease down to anaerobic conditions (Dişli et al., 2004). Chemical oxygen demand (COD) is based on the oxidation of organic matters via redox reactions rather than biochemical ones. COD is one of the most widely used collective parameters in environmental pollution. In chemical oxidation, regardless of decomposition rate or whether the substance is decomposed biologically of not, all of the organic matters are oxidized. In oxidation medium, the carbonaceous organic matters transform into CO_2 and H_2O, while nitrogenous organic matters transform into NH_3 (Samsunlu, 1999). Mean COD value of Matuf Dam is 2.88±1.36 mg/L. As stated in general literature, COD values are higher than BOD values (Dişli et al., 2004).

In irrigation ponds, there generally are sodium, potassium, calcium, and magnesium salts. When irrigating with waters containing high level of sodium content, the sodium replaces calcium and magnesium; it negatively affects the structure and permeability of soil and causes the formation of alkali (Ünlü et al., 2008; Uslu and Türkman, 1987). The concentration of sodium salt varies between 2 and 1000 m/L in natural waters (Tepe, 2009). Mean sodium level in surface water was found to be 53.79±0.71 mg Na^+/L. The highest value was observed in 3rd station as 53.88±13.50, while the lowest value was found to be 37.24±13.28 in 1st station (Table 1). Statistically significant difference was found between the monthly changes of sodium concentration ($p<0.05$). Potassium is another pollution parameter that can be examined like sodium. The concentration of potassium in natural waters ranges between 1 and 10 mg/L (Tepe, 2009), and annual mean potassium level of Maruf Dam was calculated to be 2.4728±1.47 mg/L. Relatively high levels of potassium (>1-2 mg/L) may be explained with precipitation washing the potassium fertilizers off from near agricultural lands (Hütter, 1992). Since calcium constitutes the foundation of skeletal structure of living creatures, it is very important from biological aspect. Magnesium, on the other hand, is important since it is an important component of chlorophyll molecule (Taş, 2006). Low concentration of magnesium significantly affects the phytoplankton productivity of the dam (Egemen, 2006). Mean Ca^{++} was found to be 44.49±15.17 mg/L in the research field. These 2 ions are the main elements constituting the hardness of water (Taş, 2006). High concentrations will limit the usability as potable, industrial, and irrigation water (Dişli et al., 2004).

The classification of potable and usage waters according to the hardness values is performed according to different standards in many countries. Total hardness is classified in mg/L with $CaCO_3$ equivalent; the values between 0 and 50 indicate soft water, 50-100 mid-soft, 100–150 slightly hard, 150–250 mid-hard, 250–350 hard, and >350 very hard water (Egemen and Sunlu, 1999). Total hardness of surface water was found to be 254.87±21.35 mg $CaCO_3$/L. Accordingly, the water of Maruf Dam was classified as “Mildly Hard Water”.

Suspended solid matters affect the photosynthesis by preventing the sunbeams from aquatic plants, and cause decreases in dissolved oxygen level in water. Moreover, it negatively affects the habitats of benthic creatures living in the bottom of dam (Ünlü et al., 2008). Suspended solid matter level of Uluabat Pond was found to be 38.27±40.69 mg/L. On the other hand, the mean SSM level in Maruf Dam was determined to be 4.61 mg/L. The highest level of SSM was observed in 3rd station in September as 9.62 mg/L, while the lowest value was found to be 1.2 mg/L in 2nd station in February. According to the Water Pollution Control Regulation (WPCR), the limit values are between 5 and 15 mg/L.

The chloride content indicates high level of mineral concentration in waters. The chloride content of natural waters originates from geological formations, with which the water is in contact. On the other hand, the chloride concentration might also indicate the pollution originating from industrial and domestic wastes or it might increase as a result of merge of salty waters into fresh waters (Dişli et al., 2004; Şengül and Müezzinoğlu, 2005; Ünlü et al., 2008). The chloride level of Maruf Dam was significantly low. The high concentrations of salt are not desired in irrigation waters, since it accelerates the desertification (Taş 2006). Total salt concentration of Maruf Dam (333.45 mg/L) indicates that the dam has low salt concentration (Uslu and Türkman, 1987; Anonymous, 1991).

Nitrate is a mineral that is widely seen in waters rich in oxygen, and is an important factor that might limit or increase the algal growth. The pollution of waters with nitrate occurs as a result of excessive use of nitrogenous fertilizers, oxidation of ammonia emerging as a result of decomposition of animal and herbal wastes, discharge of domestic and industrial waste waters without purification, and uncontrolled removal or storage of animal wastes (Mutlu et al., 2016a). According to WPCR, nitrate level of 5 mg/L indicates Class I, 10 mg/L indicates Class II (slightly polluted) 20 mg/L Class III (polluter water), and >20mg/L indicates Class IV (excessively polluted water). Mean nitrate level of all the samples taken from Maruf Dam was calculated to be 4.21±3.0726 mg/L (Table 1). According to WPCR, Maruf Dam is Class I in terms of nitrate concentration.

The ammonium nitrogen level (0.00±0.00 mg/L) of Maruf Dam higher than NH_4^+-N concentration is believed to originate from residential areas around the dam and domestic or agricultural contamination (Hütter, 1992).

Phosphor is one of the key elements for multidimensional and complex chemical balance in aquatic environments. Phosphor, which especially limits the growth of autotroph and heterotroph organisms performing photosynthesis, hinders their growth if its concentration is not at sufficient level (Ünlü et al., 2008). There are various forms of phosphor in waters. Orthophosphate is the main phosphor sources of ponds, and it is the single phosphate compound that can be used by many plants and microorganisms (Dişli et al., 2004; Taş, 2006). The orthophosphate phosphor concentration of Maruf Dam was found to be 0.33±0.11 mg/L. It was observed that the annual total phosphor concentration of dam didn't exceed beyond the eutrophication limits set in WPCR Table II (0.005-1.0 mg/L) (Anonymous, 2004).

For the increase of productivity in natural waters, there should be sulfate in the medium. Insufficient sulfate content in a medium prevents the phytoplankton development and slows the growth of plants. Thus, the biological productivity decreases. Moreover, under anaerobic conditions, the sulfate ion is used in chemosynthetic reactions by sulfur bacteria in degrading into sulfuric hydrogen. In natural lakes, the sulfate values vary between 3 and 30 mg/L (Atıcı et al., 2005; Taş, 2006). Mean sulfur ion concentration in Maruf Dam (64.55±9.04 mg/L) is believed to be affected the sulfate entrance from the agricultural and residential areas around the pond.

Table 1. The change of physicochemical parameters in Maruf Dam between 2015and 2016 (Range, mean, and standard deviation)

Parameters		1st station	2nd station	3rd station
(T °C)	Range	20.60	15.05	20.9
	Mean±SD	14.17±7.10	20.8±7.75	14.41±7.16
pH	Range	0.49	0.5	0.5
	Mean±SD	8.12±0.16	8.15±0.17	8.14±0.15
EC	Range	196.02	154.4	
	Mean±SD	153.4±53.53	206±57.71	
DO (mg/L)	Range	2.9	2.89	2.9
	Mean±SD	11.28±0.88	11.04±0.90	11.25±0.89
BOD (mg/L)	Range	1.52	1.34	1.54
	Mean±SD	1.2±0.55	1.15±0.54	1.22±0.55
COD (mg/L)	Range	4.58	2.67	4.6
	Mean±SD	2.88±1.40	3.08±1.13	2.91±1.41
K (mg/L)	Range	0.00	5.76	12.4
	Mean±SD	0.00±0.00	7.88±1.67	8.98±3.47
Na	Range	53.89	32.98	36.5
	Mean±SD	37.24±13.28	50.59±10.59	53.88±13.50
Cl	Range	3.34	3.26	3.32
	Mean±SD	4.88±1.20	4.84±1.18	4.91±1.19
Ca	Range	57.54	39.42	56.82
	Mean±SD	44.47±15.69	41.88±11.77	44.69±15.54
Mg	Range	33.0	32.92	32.98
	Mean±SD	35.30±11.29	35.84±11.69	35.37±11.27
T-Hardness (mg/L)	Range	60.44	60.48	60.56
	Mean±SD	243.76±21.82	245.91±23.09	245.65±21.79
T- Alkalinity	Range	61.34	61.46	61.2
	Mean±SD	253.63±21.91	255.97±23.42	256.09±22.05
TDS	Range	4.62	8.36	8.38
(mg/L)	Mean±SD	8.38±2.92	5.06±3.23	4.64±2.92
NH_4±N (mg/L)	Range	0.00	0.00	0.00
	Mean±SD	0.00±0.00	0.00±0.00	0.00±0.00
NO_2±N (mg/L)	Range	0.00	0.00	0.00
	Mean±SD	0.00±0.00	0.00±0.00	0.00±0.00
NO_3±N(mg/L)	Range	0.03	6.7	11.42
	Mean±SD	0.03±0.00	3.35±1.92	4.26±3.20
PO_4±P (mg/L)	Range	0.36	0.288	0.38
	Mean±SD	0.34±0.11	0.28±0.10	0.36±0.12
SO_4 (mg/L)	Range	32.2	29.18	31.64
	Mean±SD	64.4±32.2	63.41±7.94	64.79±9.39
SO_2 (mg/L)	Range	1.26	1.26	1.24
	Mean±SD	**1.92±0.36**	**1.86±0.33**	**1.955±0.36**

Mean heavy metal concentrations found in water samples are presented in Table II. Ferrous, copper, lead, cadmium, mercury, nickel, and zinc, which indicate the natural or anthropogenic pollution, are the heavy metals. The copper enters into water from various sources such as domestic tools, woodworking and metal companies, use of pesticide, fertilizers, and wastewaters (Duman et al., 2007). The copper concentration of Maruf Dam was found to be 6.5 µg/L. The nickel mainly comes from metal companies and canalization tanks. Nickel concentration in lakes and rivers were reported to be at low levels in general (Duman et al., 2007). The nickel concentration of Maruf Dam was found to be 2.84 µg/L. Zinc is another important element for organisms. It plays important role in structural and functional integrity of cells. It also plays role in gene expression and growth (Clearwater et al., 2002). The mean level of zinc in Maruf Dam was found to be 12.14 µg/L. Cadmium originates from various sources such as plastic, fossil fuels, metal companies, fertilizers, and cesspit. It is a trace element, which is easily taken and enters into food chain (Jain, 2004), might hinder the intake of nutritive elements such as zinc (Charles et al., 2001). The level of cadmium in Maruf Dam was found to be 0.21 µg/L. Ferrous plays important role in development of many organizations, especially the development of algae. Even though it has no place in structure of chlorophyll, it plays catalyzer role in synthesis of chlorophyll, and it is effective in respiratory metabolism of animals, as well as in enzymatic reactions (Cirik and Cirik, 1999). Mean level of ferrous was reported to be 0.00 mg/L in Maruf Dam. According to WPCR (2008), the dam is Class I. It also meets the criteria of potable water. Ferrous concentration of potable and usage waters higher than 0.3 mg/L negatively affects the taste. According to the Intracontinental Water Source Classification, the quality of water is Class I in terms of lead and mercury.

Table 2. Natural and acceptable limits of heavy metals being examined

Heavy metal	Mean	Allowed in intracontinental waters (Angelidis and Aloupi,2000)	Allowed in intracontinental waters and seas (Balkis,1998)
Fe (mg/L)	0.0005	0.7	1.0
Pb (µg/L)	0.816	0.1	0.065
Cu (µg/L)	5.41	0.01	0.013
Cd (µg/L)	0.16	0.01	0.043
Hg (µg/L)	0.004		
Ni (µg/L)	15.57	0.3	0.47
Zn (µg/L)	12.35	0.09	0.12

Principal Components Analysis and Factor Analysis Results

The Principal Analysis results of 20 parameters being examined for Maruf Dam are presented in Figure 2. This procedure performs a factor analysis. The purpose of the analysis is to obtain a small number of factors, which account for most of the variability in the 20 variables. In this case, 3 factors were extracted, since 3 factors had eigenvalues greater than or equal to 1.0. Together they account for 90.79% of the variability in the original data. Since you have selected the principal components method, the initial communality estimates have been set to assume that all of the variability in the data is due to common factors.

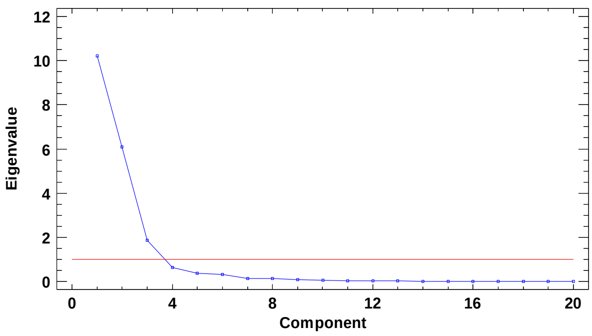

Figure 2. Slope line graph.

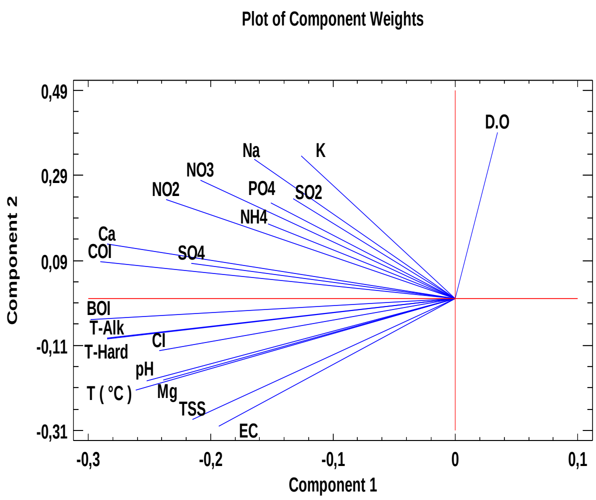

Figure 3. Loads on 2 main axes of PCA

Correlational PCA explains 61% of total variation (51.05% first axis and 30.46% second axis) (Table 2). PCA biplot clearly indicates the correlation between different variables as also the relative importance of each variable in explaining the overall variability in the environmental data (Figure 3). PCA analysis results also revealed that the first component comprised DO. The second was associated with K, Na, PO_4, SO_2, NO_3, NO_2, NH_4, Ca SO_4 and COI. Third was associated with BOD, T-alkalinity, T-Hardness, Cl, Mg, pH, T(°C), TSS, EC, PCA.

Chemical oxygen demand, electrical conductivity, and total alkalinity explained the variation, which is represented by second axis, at higher levels. Moreover, the linear relationship between temperature and electrical conductivity was revealed using PCA (Figure 3). The dissolved oxygen was related with none of the factors. From the aspect of dominance of principal dissolved ions (Na, SO_4, Mg, Ca, K), Maruf Dam exhibits a trend that is similar to that of lakes in warn regions (Wetzel 2001). Among the dynamic ions in surface waters, Ca, K. Na, SO_2, and SO_4, are located on contrary with Mg in first axis of PCA. In reality, calcium is very reactive to other dissolved ions, and exhibit significant seasonal dynamics such as epilimnetic decalcification in lakes. Sulfate, on the other hand, is primarily affected from microbial activities and chemical media such as ferrous and silica (Wetzel, 2001). The parallelism between majority anions and cations in dam suggest about the source of dissolved compounds that the main factor playing role in change of water quality in the course of time is the basin and the river feeding the dam (Alpaslan et al., 2012).

As the more independent variables than the influence of river feeding the dam and the basin geology (Goldman and Horne, 1983), the dissolved oxygen that is closely related with temperature and change in temperature was located on the contrary with anion and cation in PCA's first axis. These indicate that the water quality of Maruf Dam is mainly determined by the water collection basin and river and especially the climatic factors. On the other hand, it can be stated that in-dam reactions play important role in temporal change of some anions and cations.

According to WPCR criteria, Maruf Dam is in Class I irrigation water class in terms of mean temperature, pH, dissolved oxygen, biological and chemical oxygen demand, chloride, sulfate, nitrogen, and phosphor (Anonymous, 2004). From the aspect of salinity, the water of dam is in Class I irrigation water class. Besides that, the results obtained are lower than maximum levels of zinc, nickel, copper, lead, and cadmium.

4. DISCUSSION

In conclusion, Maruf Dam is an important fresh water source located in Boyabat district, fed by Brook Ekinveren and snow waters and having important fresh water potential. The water of dam is clear and odorless. From the aspect of potable and usage water criteria of WPCR, the water of Maruf Dam is in Class I water class (clean waters). From the aspects of pH, calcium, magnesium, potassium, chloride, ferrous, nitrate, ammonium, phosphor, and sulfate, the eutrophication control limits recommended for lakes, ponds, and dams were not exceeded. The water in dam is suitable for many fish species that already live in dam. It is a very important field for wildlife and irrigation. It can be utilized within the scope of ecotourism and recreational purposes. In future, the agricultural activities performed around the dam and in wetland might negatively affect the trophic structure and water quality of dam.

REFERENCES

Anonymous, 2007. Ramsar Convention, handbooks fort he Wise Use of Wetlands, 3 rd edn, 17 volumes. Ramsas convention Secretariat, Gland, switzerland, p.30.

Anonymous, 2004. Su Kirliliği ve Kontrolü Yönetmeliği, 31 Aralık 2004 tarihli Resmi Gazete No: 25687.

Akkan T, Kaya A, Dinçer S., 2011. Hastane Atık Sularıyla Kontamine Edilen Deniz Suyundan İzole Edilen Gram Negatif Bakterilerin Sefalosporin Grubu Antibiyotiklere Karşı Direnç Düzeyleri, Türk Mikrobiyoloji Cemiyeti Dergisi, 4(1): 18-21.

Alpaslan, K., Sesli, A., Tepe, R., Özbey, N., Birici, N., Şeker, T. ve Koçer, M.A.T., 2012. Vertical and Sea sonal Changes of Water Quality in Keban Dam Reservoir. Journal of Fisheries Sciences. com 6(3): 252-262.

Atıcı, T., Obalı, O. ve Elmacı, A., 2005. Abant Gölü (Bolu) bentik algleri, Ekoloji, 14(56), 9-15.

Charles, S., Yunus, S., Dubois, F. and Vander Donckt, E., 2001. Determination of cadmium in marine waters: on-line preconcentration and flow-through fluorescence detection, Analytica Chimica Acta, 440, 37- 43.

Cirik S, Cirik Ş., 1999. Limnoloji. III. Baskı, Ege Üniversitesi Su Ürünleri Fakültesi Yayınları No: 21, Ege Üniversitesi Basımevi, İzmir.

Clearwater, S. J., Farag, A. M. and Meyer, J. S., 2002. Bioavailability and toxicity of dietborne copper and zinc to fish, Comparative Biochemistry and Physiology Part C, Toxicology & Pharmacology, 132, 269-313.

Dişli, M., Akkurt, F. ve Alıcılar, A., 2004. Şanlıurfa Balıklıgöl suyunun bazı kimyasal parametrelerinin mevsimlere göre değişiminin değerlendirilmesi, Gazi Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi, 19, 287-294.

Doğanay, H. (1998). Ekonomik Coğrafyası 2: Enerji Kaynakları, Şafak Yayınevi, Ankara.

Duman, F., Sezen, G. and Tug, G. N., 2007. Seasonal changes of some heavy metal concentrations in Sapanca Lake Water, Turkey, International Journal of Natural and Engineering Sciences, 1(3), 25-28.

Egemen, Ö., Sunlu U., 1996. Su Kalitesi. 2. Baskı, Ege Üniversitesi Basımevi, İzmir.

Elmacı, A., Topaç, O.F., Özengin, N., Başkaya, S.H., 2010. Ulubat Gölü Fizikikimyasal özelliklerinin Yönetmelikler Çerçevesinde değerlendirilmesi. Uludağ üniversietsi Mühendislik-Mimarlık fakültesi Dergisi,:15(1):149-157

Goldman, C.R. ve Horne, A. J., 1983. Limnology McGraw-Hill, New York.

Hütter, L. A., 1992. Wasser und Wasseruntersuchung, Otto Salle Verlag, Verlag Sauerlönder.

Jain, C. K., 2004. Metal fractionation study on bed sediments of River Yamuna, India, Water Research, 38, 569-578.

Karafistan, A. and Arık-Colakoglu, F., 2005. Physical, chemical and microbiological water quality of the Manyas lake, Turkey, Mitigation and Adaptation Strategies for Global Change, 10, 127-143.

Koca, N., 2005. "Aksisar Barajı'nın (Çanakkale) Çevresel ve Ekonomik Etkileri ", Doğu Coğrafya Dergisi, sayı 14, s. 209-234, Erzurum.

Kurnaz A, Mutlu E, Aydin Uncumusaoğlu A., 2016. Determination of Water Quality Parameters and Heavy Metal Content in Surface Water of Çiğdem Pond (Kastamonu/Turkey) Turkish Journal of Agriculture - Food Science and Technology, 4(10): 907-913.

Mason, C.F. 2002. Biology of Freshwater Pollution. 4^{th} ed. Pearson-Benjamin Cummings, UK.

Mutlu E., Demir T., Yanık T. ve Anca Sutan N., 2016a. Determination of Environmentally Relevant Water Quality Parameters in Serefiye Dam-Turkey, Fresenius Environmental Bulletin, 25 (12), 5812-5818.

Orhan, F., 2015. Baraj Göllerinin Alternatif Ekonomik Faaliyetlerde kullanımı: Borçka Baraj Gölü Örneği. Marmara Coğrafya dergisi. 32:308-402.

Polat N, Akkan T., 2016. Assessment of Heavy Metal and Detergent Pollution in Giresun Coastal Zone, Turkey. Fresenius Environmental Bulletin, 25(8): 2884-2890.

Polat, S. Ç., Tuğrul, S., 1995. Nutrient and organic carbon exchanges between the Black and Marmara seas through the Bosphorus strait. Continental Shelf Res.15(9):1115-1132.

Şen, B. ve Koçer, M.A.T. 2003. Su Kalitesi İzleme. XII. Ulusal Su Ürünleri Sempozyumu, 2-5 Eylü 2003, Elazığ. pp.567-572.

Şengül, F. ve Müezzinoğlu, A., 2005. Çevre Kimyası, Dokuz Eylül Üniversitesi Mühendislik Fakültesi Basım Ünitesi, İzmir.

Taş, B. (2006) Derbent Baraj Gölü (Samsun) su kalitesinin incelenmesi, Ekoloji, 15(61), 6-15.

Temponeras M, Kristiansen J, Moustaka-Gouni M., 2000. Seasonal Variation in Phytoplankton Composition and Physical-Chemical Feactures of the Shallow Lake Doirani, Macedonia, Greece. Hydrobiologia 424, 109-122.

Tepe, Y. (2009) Reyhanlı Yenişehir Gölü (Hatay) su kalitesinin belirlenmesi, Ekoloji, 18(70), 38-46.

Tüzün, İ., İnce, Ö. ve Başaran, G., 2006. Doğal Göl Ve Rezervuar Limnolojisindeki Farklılıkların Bir eþik Yönetim Planlaması Açısından Değerlendirilmesi: Genel Yaklaşım I. Balıklandırma ve Rezervuar Yönetimi Sempozyumu, Antalya pp.237-247.

Usha, R., Ramalingam, K. and Bharathi Rajan, U. D. 2006. Fresh water lakes a potential source for aquaculture activities for model study on Perumal lake (T.N. Cuddalore), Journal of Environmental Biology, 27, 713-722.

Uslu, O. ve Türkman, A., 1987. Su Kirliliği ve Kontrolü, T.C. Başbakanlık Çevre Genel Müd. Yayınları, No:1, Ankara.

Ünlü, A., Çoban, F. ve Tunç M. S., 2008. Hazar Gölü su kalitesinin fiziksel ve inorganik kimyasal parametreler açısından incelenmesi, Gazi Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi, 23(1), 119-127.

Yılmaz, F., 2004. Mumcular Barajı (Muğla-Bodrum)'ın Fiziko-Kimyasal Özellikleri. Ekoloji, 13(50): 10- 17.

Wetzel, R.G., 2001. Limnology: Lakes and River Ecosystems. Academic Press, London.