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Research article/Araştırma makalesi

Water quality assessment of Felent Stream (Kütahya/Turkey)

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Abstract

Felent Stream is one of the most important branches of Porsuk Stream and it is affected by wastes of industrial, agricultural and thermal springs of Kütahya Province. In the present study, water quality of Felent Stream including upstream, downstream and reservoir parts of the system were investigated. For this purpose, temperature, pH, dissolved oxygen, ammonium nitrogen, nitrite nitrogen, nitrate nitrogen, sulphate, phosphate, chemical oxygen demand (COD), total phosphorus, calcium, magnesium and sodium parameters were determined on water samples collected seasonally (2010 – 2011) from seven stations selected on the basin considering the pollution sources. Also One –Way ANOVA test was applied to detected data in order to evaluate the significant water quality differences among the investigated stations. According to data observed, Felent Stream was found to be as under effect of a significant organic – thermal pollution caused form especially domestic wastes of Kütahya Province and thermal springs of Yoncalı Village.

Key words: water quality, Felent stream, one – way ANOVA

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Felent Çayı (Kütahya/Türkiye) su kalitesinin değerlendirilmesi

Özet

Felent Çayı, Porsuk Çayı'nın en önemli kollarından biridir ve Kütahya'nın sanayi, tarım ve kaplıca kaynaklı atıklarından etkilenmektedir. Bu çalışmada, sistemin yukarı, aşağı ve rezervuar kısımlarını içeren Felent Çayı'nın su kalitesi araştırılmıştır. Bu amaçla, havzada kirlilik kaynaklarını değerlendirilerek seçilen yedi istasyondan mevsimsel olarak alınan su örnekleri tıplanmış (2010 - 2011) ve bu numunelerde sıcaklık, pH, çözünmüş oksijen, amonyum azotu, nitrit azotu, nitrat azotu, sülfat, fosfat, kimyasal oksijen ihtiyacı (KOİ), toplam fosfor, kalsiyum, magnezyum ve sodyum parametreleri belirlenmiştir. Ayrıca, araştırılan istasyonlar arasındaki önemli su kalitesi farklılıklarını değerlendirmek için tespit edilen verilere Tek Yönlü ANOVA testi uygulanmıştır. Tespit edilen verilere göre, Felent Çayı'nın, özellikle Kütahya İli evsel atıklarından ve Yoncalı Köyü kaplıcalarından kaynaklanan önemli bir organik - termal kirliliğin etkisi altında olduğu tespit edilmiştir.

Anahtar kelimeler: su kalitesi, Felent çayı, tek yönlü ANOVA

1. Introduction

Lotic ecosystems play a significant role as a receiving environment of domestic – industrial – agricultural wastewater. Seasonal variations of rains, surface runoff, and groundwater flow have a strong effect on river discharges and concentration of pollutants in the river water. Water quality monitoring of lotic ecosystems helps to evaluate the pollution sources of the systems, provide an effective management of water resources and also protect the aquatic life (Shresta and Kazama, 2007; Strobl and Robillard, 2008; Tokatlı, 2013; Tokatlı et al., 2014; Köse et al., 2015; Tokatlı, 2015).

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Felent Stream is one of the most important branches of Porsuk Stream that is the most important element of Sakarya River Basin. It has a Dam Lake (Enne Dam Lake) on the watershed boundaries and exposed to a significant pollution. Agricultural applications, thermal hotels located on the upstream of the basin and solid waste storage area located on the downstream of the basin are known as the main pollution factors for the system (Çiçek et al., 2013; Tokatlı et al., 2013).

The aim of this study was to evaluate the water quality of Felent Stream Basin by determining some limnologic parameters including temperature, pH, dissolved oxygen, ammonium nitrogen, nitrite nitrogen, nitrate nitrogen, sulphate, phosphate, chemical oxygen demand (COD), total phosphorus, calcium, magnesium, potassium, which are especially thought to best reflect the agricultural and organic pollution on the system.

2. Materials and methods

2.1. Study area

Kütahya Province is one of the most important locations in Turkey due to being the vanishing point of different phyto – zoo geographical regions (Irano – Turanian, Mediterranean, and European – Siberian). Kütahya, which is located at the junction of the Sakarya River Basin, in the Inner Anatolian part of the Aegean Region, extends between the souths – western edge of an alluvial plain watered by Felent Stream (Solak et al., 2012).

Felent Stream has a length of 35 km and the average flow rate of the stream is 0.56 m3/s. It is the most important branch of Porsuk Stream and exposed to a significant pollution (Anonymous, 2006; Tokatlı et al., 2012). The study area and selected stations on the Felent Stream Basin are given in Figure 1. Water samples were collected seasonally between the dates of February 2011 – January 2012.

F1 station was located quite close to the source of Felent Stream and away from pollution and any waste discharge. F2 station was located on the Köprüören Village and agricultural activities are intensively conducted around this station. F3 station was located on the Yoncalı Village, where known as the termal turistic place of Kütahya Province. F4 station was located on the Enne Dam Lake and water samples were collected from a close area to the output of the reservoir. F5 station was located on the Felent Stream after from the output of the Enne dam Lake. F6 station was located quite close to the solid waste disposal site of Kütahya Province. F7 station was located in the Kütahya Province and it was the last station before falling Porsuk Stream.

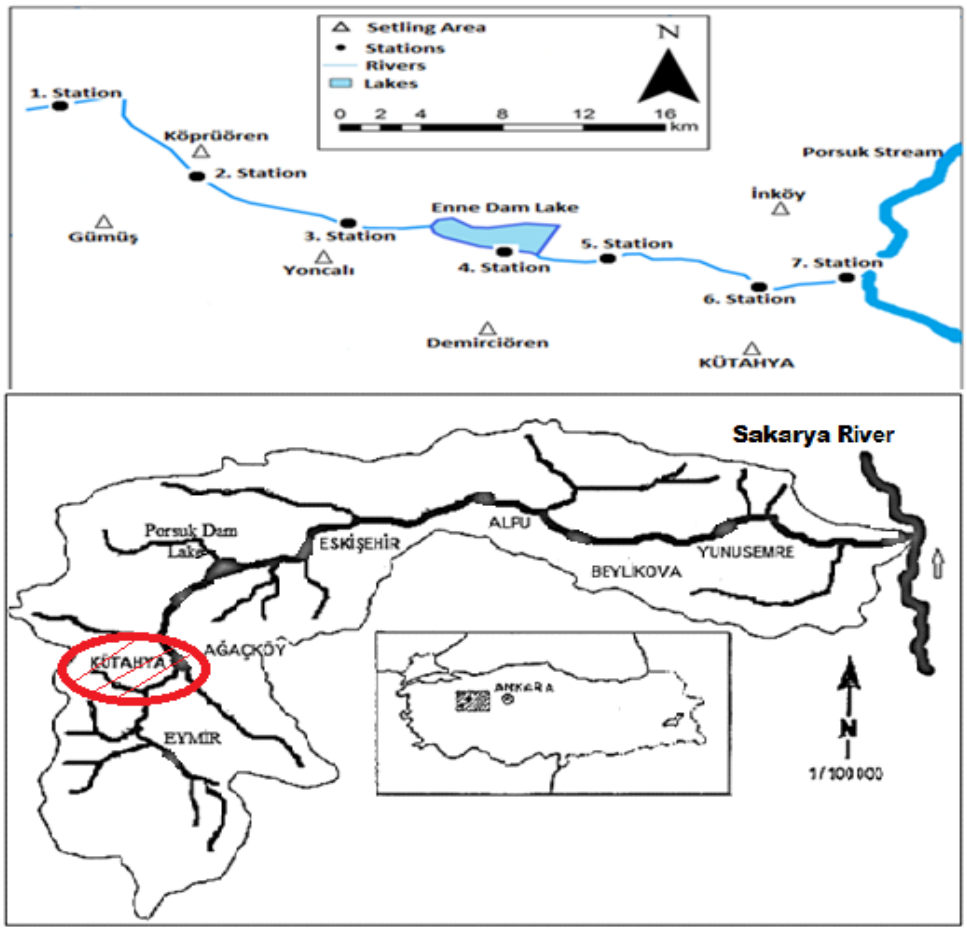


Figure 1. Porsuk Stream Basin, Felent Stream and selected stations

2.2. Physicochemical analysis

Measurements of temperature (T), pH, dissolved oxygen (DO) and electrical conductivity (EC) in water of Felent Sreek were performed in situ by using Hach branded (HQ40d) Portable Multi – Parameter Measurement Device during the field studies.

Ammonium nitrogen (NH_4–N), nitrite nitrogen (NO_2–N), nitrate nitrogen (NO_3–N) and sulphate (SO_4), phosphate (PO_4), chemical oxygen demand (COD) were measured by using Hach branded (DR 2800) Spectrophotometer Device.

Water samples of one liter that were taken at each sampling point were adjusted to pH 2 by adding 2 ml of nitric acid into each for determination of Ca, Mg, Na and K. Afterwards, the samples were filtered (cellulose nitrate, 0.45 µm) in such a way as to make their volumes to 100 ml.

For determination of total phosphorus in water, 100 ml from samples were transferred to a 250-ml beaker and 2 ml (1+1) of nitric acid and 1 ml (1+1) of hydrochloric acid were added. And then put on hot plate for evaporation to nearly dryness, making certain that the samples do not boil at 85^0C. Sample volume was come down to approximately 20 ml. Afterwards, the samples were filtered (cellulose nitrate, 0.45 µm) in such a way as to make their volumes to 50 ml with ultra-pure water. Total phosphorus, calcium, magnesium, potassium and sodium elements were measured by using ICP – OES device (U.S. EPA, 2001).

2.3. Statistical analysis

One – Way ANOVA test was applied to detected data by using SPSS 17 statistical packed program in order to evaluate the significant differences among the stations in terms of investigated water quality parameters at the 0.05 – 0.01 levels. Scatter – dot diagrams were applied to detected data by using SPSS 17 statistical packed program in order to provide a visual summary of investigated parameters to make them easy to compare with water quality standards.

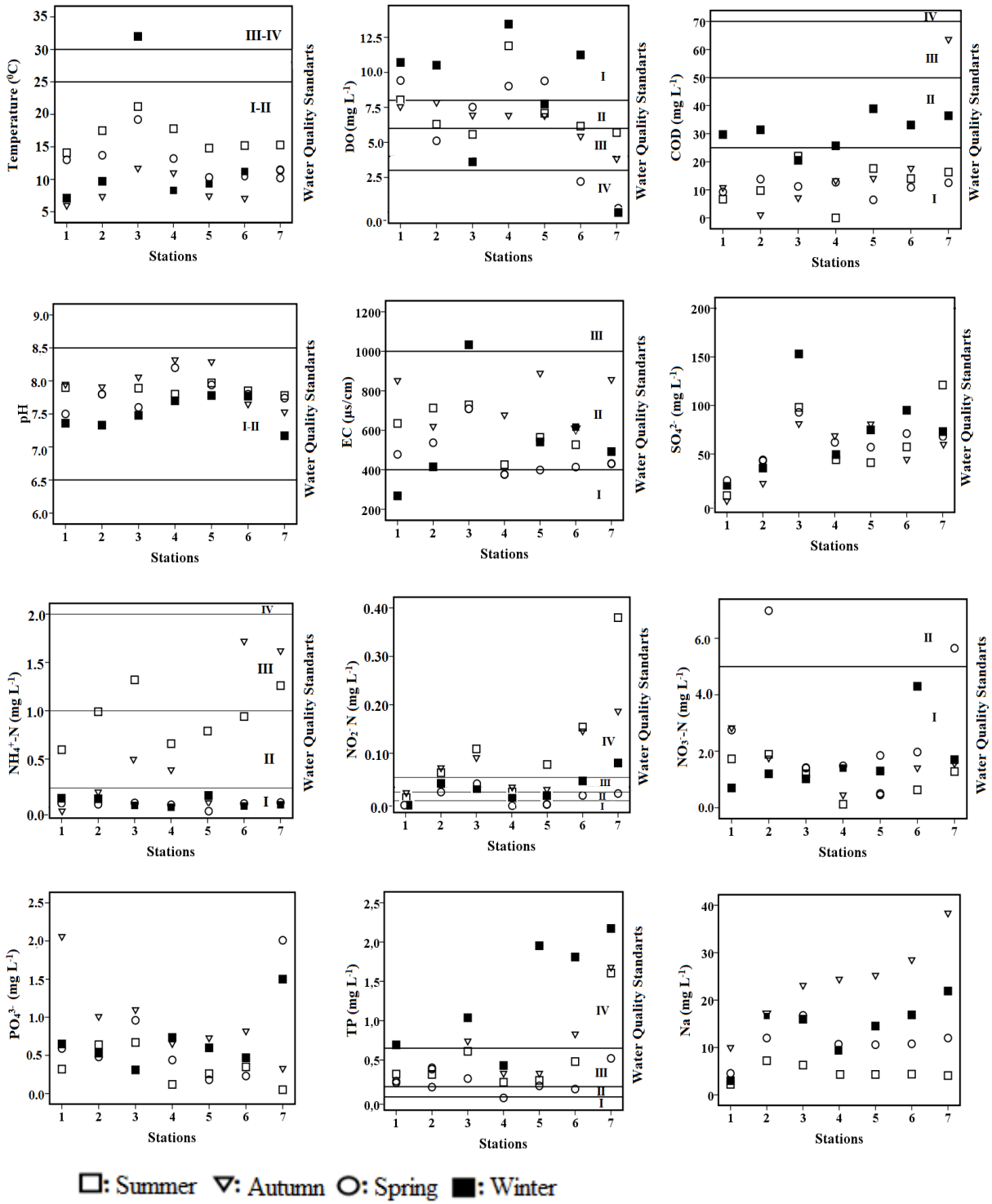
3. Results

Seasonally water quality values recorded in water of Felent Stream are given in Figure 2 and also annual water quality values with the results of One – Way ANOVA test are given in Table 1. Water quality regulations in Turkey separate the inland waters into four classes; Class I refers to high – quality water that can be used for high potential for drinking water and recreational purposes, Class II refers to less contaminated water that can be used as potential for drinking water and recreational purposes, Class III includes polluted water that can only be used as industrial water after treatment, and Class IV refers to heavily polluted water that should not be used at all (Turkish Regulations, 2012).

Ca, Mg, K and Na values in water of Felent Stream were stable in general and they were ranged between 20.99 – 201 mg L^{-1}, 6.87 – 74.61 mg L^{-1}, 1.31 – 60.5 mg L^{-1} and 2.23 – 38.35 mg L^{-1} respectively. According to the results of One – Way ANOVA test, no statistically significant differences was found among the stations in terms of Ca, Mg, K and Na levels. The temperature values detected in the 3rd station were significantly higher than the other stations ($p<0.05$) and the highest temperature value was measured in 3rd station as 32 ^{0}C in winter season. This station was located in the Yoncalı Village of Kütahya and there are many thermal hotels around there. Thermal waste waters of Yoncalı Village were being discharged into the Felent Stream on this point and this sudden increase of temperature value in water has a significant negative impact on the aquatic flora and fauna in this location. In a study performed in the same stream by Tokatlı et al (2012), water quality of this location was found to be in a very low level in terms of especially temperature values.

Changes in pH values in surface water ecosystems can be indicative of an industrial pollutant, photosynthesis or the respiration of algae that is feeding on a contaminant. Most ecosystems are sensitive to changes in pH and the monitoring of pH has been incorporated into the environmental laws of most industrialized countries (Ugwu and Wakawa, 2012). In a macroscopic point of view, Felent Stream has an alkaline water characteristics and pH data in water of Felent Stream were recorded between the values of 7.17 (in station 7th, winter season) and 8.29 (in station 5th, spring season). According to the results of One – Way ANOVA test, no statistical differences were determined among the stations in terms of pH values ($p<0.05$).

Electrical Conductivity (EC) in natural waters is the normalized measure of the water's ability to conduct electric current. This is mostly influenced by dissolved salts such as sodium chloride and potassium chloride (Ugwu and Wakawa, 2012). The highest EC values in Felent Stream were determined in 3rd station as 1033 µs/cm in winter season and according to the Turkish Regulations, Felent Stream has II. Class water quality in general in terms of EC values (Turkish Regulations, 2012). In a study performed by Solak et al. (2012), water quality of Felent Stream were investigated. According to the results of this study, Felent Stream had II. – III. Class water quality in general in terms of EC and temperature parameters as similar to the present study. They also reported that Felent Stream was significantly affected by domestic sewage and thermal tourism and this situation may cause these extreme temperature and EC values detected in especially Yoncalı Village. The amount of dissolved oxygen in the water at any time is depending on temperature of water, partial pressure of gas in the atmosphere in contact with the water surface, salinity of water, biological processes in water (Tanyolaç, 2009).



I-II-III-IV. Classis: Water Quality Standards for Turkish Regulations

Figure 2. Seasonally values of some water quality parameters.

The highest DO value was recorded in 4th station as 13.45 mg L^{-1} in winter season and the lowest DO values were recorded in 7th station in general in all seasons. The DO values detected in the 7th station were also significantly lower than the other stations ($p<0.05$). This station was located on the output of Kütahya Province and affected by domestic, industrial and agricultural wastes. Also it was the last sampling point before falling the Porsuk Stream. In a study performed in Porsuk Stream by Köse et al. (2016), DO values detected in the output of Kütahya Province were in a very low level (annual means of DO values was 2.74 mg L^{-1}).

The highest COD value was determined in 7th station as 63.6 mg L^{-1} in autumn season. But according to the results of One – Way ANOVA test, no statistically significant difference was determined among the stations in terms of COD levels ($p<0.05$). According to the Turkish Regulations, Felent Stream has I. – II. Class water quality in general in terms of COD levels (Turkish Regulations, 2012).

The highest NO_2–N was found as 0.38 mg L^{-1} in 7th station. According to Turkish Regulations (2012), 3th, 6th and 7th stations of Felent Stream has III. Class water quality in terms of nitrite levels and also NO_2–N values recorded in water of station 7th was significantly higher than other stations ($p<0.05$). In a study performed in Kütahya Province, trophic status of Upper Porsuk Stream Basin was investigated by using some diatom indices. According to the results of this study, water quality levels were found as eutrophic and organically polluted in general as similar to the present study (Solak, 2011). The highest ammonia nitrogen was determined in 6th station as 1.72 mg L^{-1} in autumn season and the lowest ammonia nitrogen was determined in 5th station, where was located on the output of the dam lake, as 0.028 mg L^{-1} in spring season. Nitrate values determined in the basin were in low levels in general and according to Turkish Regulations, Felent Stream has I. Class water quality in terms of nitrate values (Turkish Regulations, 2012).

The highest total phosphorus levels were determined in 7th station and also total phosphorus levels recorded in this station were significantly higher than the other stations ($p<0.05$). According to Turkish Regulations, 3rd, 5th, 6th and 7th stations of Felent Stream has IV. Class water quality in terms of this parameter (Turkish Regulations, 2012). These results may reflect that agricultural, domestic, and livestock activities conducted around the Felent Stream Basin adversely affect the water quality. As similar to the present study, Varol et al. (2012) reported that total phosphorus and nitrate levels detected in winter and spring seasons were higher than detected in summer and autumn seasons in Tigris River because of high surface runoff during the rainy seasons.

4. Conclusions and discussion

In this study, water quality of Felent Stream Basin was evaluated by investigating some water quality parameters and by using One – Way ANOVA test. As a result of the present study, it can be concluded that Felent Stream Basin is under effect of a significant agricultural, domestic and thermal pollution and this adverse situation also cause to reduce the water quality of Porsuk Stream. It can also concluded that the reservoir located on the watershed has a significant cleaning capacity and water quality of Felent Stream was increasing after output of the dam lake.

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References

Anonymous (2006). Kütahya İl Çevre Durum Raporu. T.C. Kütahya Valiliği İl Çevre ve Orman Müdürlüğü, 324syf.

Çiçek, A., Tokatlı, C., Köse, E. (2013). Ecological Risk Assessment of Heavy Metals in Sediment of Felent Stream (Sakarya River Basin, Turkey). Pakisan Journal of Zoology, 45 (5): 1335-1341.

Köse, E., Çiçek, A., Uysal, K., Tokatlı, C., Emiroğlu, Ö., Arslan, N. (2015). Heavy Metal Accumulations in Water, Sediment and Some Cyprinidae Fish Species From Porsuk Stream (Turkey). Water Environment Research, 87 (3): 195-204.

Köse, E., Çiçek, A., Uysal, K., Tokatlı, C., Emiroğlu, Ö., Arslan, N. (2016). Evaluation of Surface Water Quality In Porsuk Stream. Unıversıty Journal of Scıence and Technology – C Life Sciences and Biotechnology, 4 (2): 81-93.

Shrestha, S., Kazama, F. (2007). Assessment of surface water quality using multivariate statistical techniques: A case study of the Fuji river basin, Japan. Environmental Modelling & Software 22,464-475.

Solak, C. N. (2011). The Application of Diatom Indices in the Upper Porsuk Creek Kütahya - Turkey. Turkish Journal of Fisheries and Aquatic Sciences 11: 31-36.

Solak, N. C., Barınova, S., Acs, E., Dayıoğlu, H. (2012). Diversity and ecology of diatoms from Felent creek (Sakarya river basin), Turkey. Turkish Journal of Botany, 36: 191-203.

Strobl, R.O., Robillard, P. D. (2008). Network design for water quality monitoring of surface freshwaters: a review. Journal of Environmental Management 87, 639–648.

Turkish Regulations (2012). Yüzeysel Su Kalitesi Yönetimi Yönetmeliği. 30 Kasım 2012 tarihli Resmi Gazete No: 28483, http://suyonetimiormansu.gov.tr.

Tanyolaç, J. (2009). Limnoloji. Hatiboğlu Yayınevi, Ankara, 294 s.

Tokatlı, C. (2013). Use of Statistical Methods in Water Quality Assessment: A Case Study of Balkan Arboretum Area in Trakya University (Edirne, Turkey). Journal of Applied Biological Sciences, 7 (3): 79-83.

Tokatlı, C., Köse, E., Çiçek, A., Arslan, N. and Emiroğlu, Ö. (2012). Evaluations of Water Quality and the Determination of Trace Elements on Biotic and Abiotıc Components of Felent Stream (Kütahya, Sakarya River Basin/Turkey). Biological Diversity and Conservation, 5 (2): 73-80.

Tokatlı, C., Çiçek, A., Köse, E., Emiroğlu, Ö. (2013). Uptake of Silver From Large Silver Deposits on Biotic and Abiotic Components of the Closest Lothic System: Felent Stream, Turkey. Pakistan Journal of Zoology, 45 (3): 701-707.

Tokatlı, C., Köse, E., Çiçek, A. (2014). Assessment of the Effects of Large Borate Deposits on Surface Water Quality by Multi Statistical Approaches: A Case Study of The Seydisuyu Stream (Turkey). Polish Jour. of Envir. Studies, 23 (5): 1741-1751.

Tokatlı, C. (2015). Assessment of the Water Quality in the Meriç River: As an Element of the Ecosystem in the Thrace Region of Turkey. Polish Journal of Environmental Studies, 24 (5): 2205-2211.

Ugwu, A.I. and Wakawa, R. J. (2012). A study of seasonal physicochemical parameters in River Usma. American Journal of Environmental Science, 2012, 8 (5): 569-576.

U.S. EPA (2001). Determination of metals and trace elements in water and wastes by inductively coupled plasma-atomic emission spectrometry. EPA method 200.7.

Varol, M., Gökot, B., Bekleyen, A. and Şen, B. (2012). Spatial and temporal variations in surface water quality of the dam reservoirs in the Tigris River basin, Turkey. Catena 92: 11–21.

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Table 1. Annual average values of water quality parameters and the results of One – Way ANOVA test* (mean±SE)

Parameters	Stations						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Temperature (°C)	10.12±2.04 [a]	12±2.23[a]	21.3±4.18[b]	12.57±2.01[a]	10.48±1.56[a]	10.96±1.66[a]	12.1±1.11[a]
Dissolved Oxygen (mg/L)	9.02±0.65 [a]	7.44±1.16 [a]	5.91±0.86[a]	10.33±0.56 [a]	7.78±0.56 [a]	6.26±1.87[a]	2.50±1.35 [b]
pH	7.68±0.14 [a]	7.71±0.12 [a]	7.76±0.13 [a]	8.32±0.26 [a]	8.42±0.52[a]	7.77±0.04[a]	7.55±0.13 [a]
EC (µs/cm)	558.25±123.44 [a]	571.25±63.28 [a]	795.70±79.56 [a]	464.23±144.39 [a]	598.24±103.55 [a]	541.25±46.93 [a]	553.75±102.43 [a]
Salinity (‰)	0.32±0.04 [a]	0.33±0.01 [a]	0.39±0.01[a]	0.21±0.06 [a]	0.35±0.04[a]	0.32±0.03[a]	0.33±0.05
SO_4^{3-} mg /L)	9.98±3.64 [a]	35.5±5.57 [ab]	106.30±15.96[c]	57.12±4.99[b]	63.45±9.01 [bc]	66.95±10.80[bc]	82.85±12.82[c]
PO4 (mg /L)	0.90±0.39 [a]	0.66±0.11 [a]	0.76±0.17[a]	0.50±0.14 [a]	0.44±0.13[a]	0.47±0.12 [a]	0.97±0.46 [a]
NH_4–N (mg /L)	0.17±0.14 [a]	0.32±0.20 [a]	0.47±0.30 [a]	0.25±0.15 [a]	0.22±0.17 [a]	0.68±0.40 [a]	0.74±0.41 [a]
NO_2–N (mg /L)	0.009±0.008 [a]	0.05±0.01 [a]	0.07±0.01 [a]	0.013±0.004 [a]	0.032±0.01 [a]	0.089±0.03 [a]	0.17±0.07 [b]
NO_3–N (mg /L)	2.00±0.50 [a]	2.96±1.34 [a]	1.26±0.09 [a]	0.86±0.34 [a]	1.03±0.33[a]	2.08±0.79[a]	2.55±1.03 [a]
COD (mg/L)	14.11±5.26 [a]	14.2±6.3 [a]	15.2±3.58[a]	12.93±5.24 [a]	19.26±6.90 [a]	18.93±4.92 [a]	32.2±11.41 [a]
Ca (mg/L)	60.16± 9.80 [a]	59.13±9.39 [a]	89.81±18.81 [a]	55.86±13.13 [a]	86.65±18.96 [a]	80.91±20.14 [a]	117.08±31.11 [a]
Mg (mg/L)	44.88±6.52 [a]	49.55±9.08 [a]	28.34±7.27 [a]	38.14±10.36 [a]	37.94±9.42 [a]	33.29±5.84 [a]	33.75±6.47 [a]
Na (mg/L)	4.931±0.75 [a]	13.25±2.32 [a]	15.52±3.47 [a]	12.03±4.29 [a]	13.65±4.38 [a]	15.12±5.13 [a]	19.08±7.38 [a]
TP (mg/L)	0.36±0.11[a]	0.31±0.06[a]	0.66±0.16[ab]	0.24±0.08[a]	0.67±0.42[ab]	0.86±0.36 [b]	1.51±0.34[c]
K (mg/L)	(2.34±0.59)[a]	7.36±3.03[a]	5.75±0.63[a]	4.30±0.87[a]	18.29±14.09[a]	5.17±1.25[a]	14.92±6.46[a]

*The value with a different letter in the same row is statistically different ($p<0.05$)