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Short Communication

WATER QUALITY ASSESSMENT OF DAM LAKES LOCATED IN EDIRNE PROVINCE (TURKEY)

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ABSTRACT

Edirne Province is located in the Thrace part of Marmara Region and intensive agricultural activities are conducted around the city, because of contained rich soil and much freshwater resources. In this study, water quality of Sultanköy (İpsala District), Altınyazı (Uzunköprü District), Süloğlu (Süloğlu District), and Kadıköy (Keşan District) Dam Lakes, which were constructed by DSİ (State Water Works) in order to provide irrigation water (Sultanköy and Altınyazı) and drinking water (Süloğlu and Kadıköy) to the places where they are located on, were investigated. For this purpose, water samples were collected from the output locations of all the reservoirs in spring season of 2016. Total of 13 physiochemical water quality parameters (pH, conductivity, TDS, salinity, turbidity, nitrate, nitrite, phosphate, sulfate, chemical oxygen demand, total carbon, total inorganic carbon and total organic carbon) were measured. Also Cluster Analysis (CA) was applied to detected data in order to classify the reservoirs in terms of contamination levels. According to detected data, pollution levels of the investigated dam lakes as follows; Sultanköy > Altınyazı > Kadıköy > Süloğlu in general. According to the results of CA, 3 statistically significant clusters were formed, which were corresponded to Süloğlu Dam Lake (Cluster 1); Kadıköy and Altınyazı Dam Lakes (Cluster 2); Sultanköy Dam Lake (Cluster 3).
Keywords: Sultanköy, Altınyazı, Süloğlu, Kadıköy, Dam lakes, water quality, cluster analysis.

1. INTRODUCTION

Freshwater pollution is a matter of serious global concern today and unfortunately our water resources continuous to be more polluted day by day (Strobl and Robillard, 2008). It is required to assess a large number of physicochemical water quality data for an effective contamination control. Water quality assessment is also useful and necessary for an effective management of water resources (Dixon and Chiswell, 1996; Köse et all., 2014). Multivariate statistical techniques like Cluster Analysis (CA) helps to interpretation of complex data matrices to better understand the investigated freshwater environment (Shrestha and Kazama, 2007; Tokatlı, 2013; Tokatlı et al., 2014a).

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Sultanköy , Altınyazı, Süloğlu and Kadıköy Dam Lakes are the most important reservoirs of Edirne Province constructed to provide irrigation and drinking water to the local people (http://www2.dsi.gov.tr/). But as many freshwater ecosystems, they are under effect of a significant agricultural and domestic pressure.

The aim of this study was to evaluate the water quality of Sultanköy, Altınyazı, Süloğlu and Kadıköy Dam Lakes by determining some limnologic parameters including pH, electrical conductivity (EC), total dissolved solid (TDS), salinity, turbidity, Nitrate nitrogen (NO_3), nitrite nitrogen (NO_2), sulphate (SO_4), phosphate (PO_4), total carbon (TC), total inorganic carbon (TIC), total organic carbon (TOC) and chemical oxygen demand (BOD) and classify the reservoirs according to water quality characteristics by using Cluster Analysis (CA).

2. MATERIALS AND METHODS

2.1. Study Area and Collection of Samples

Sultanköy, Altınyazı, Süloğlu and Kadıköy Dam Lakes and selected stations on the reservoirs are given in Figure 1. Coordinate informations of stations and some explanations about the dam lakes are given in Table 1. Water samples were collected in spring season of 2016 and one sample was taken from each selected stations on the dam lakes.

Table 1. Location properties of selected stations (http://www2.dsi.gov.tr/)

Name of Dam Lakes	Coordinates of Stations		Name of Feeding Stream	Construction Date	Trunk Volume	Aim of Construction	Irrigation Area
	North	South					
Sultanköy	41.037195	26.479766	Manastır	1996	1762dam^3	Irrigation	7773ha
Altınyazı	41.079092	26.587323	Basamaklar	1970	524dam^3	Irrigation, Flood Protection	7730ha
Süloğlu	41.790001	26.918213	Süloğlu	1981	1320dam^3	Irrigation, Flood Protection, Drinking water	3986ha
Kadıköy	40.793424	26.773206	Derbent	1975	185dam^3	Irrigation, Flood Protection, Drinking water	69ha

2.2. Physicochemical Analysis

Measurements of pH, electrical conductivity (EC), total dissolved solid (TDS) and salinity parameters were performed by using Hach branded (HQ40D) Portable Multi – Parameter Measurement Device and turbidity parameter was performed by using Hach branded (2100Q) Portable Turbidimeter Device during the field studies. Nitrate nitrogen (NO_3), nitrite nitrogen (NO_2), sulphate (SO_4), phosphate (PO_4), total carbon (TC), total inorganic carbon (TIC), total organic carbon (TOC) and chemical oxygen demand (COD) parameters were performed by using Hach branded (DR3900) Spectrophotometer Device during the laboratory studies.

2.3. Statistical Analysis

The primary purpose of Cluster Analysis (CA) is assembling objects based on the characteristics they possess. Hierarchical agglomerative clustering is one of the most common approaches in CA. It provides intuitive similarity relationships between any one sample and the entire data set and is typically illustrated by a dendrogram in order to provide visual summaries of

clustering processes (Shrestha and Kazama, 2007; Tokatlı, 2013). Bray Curtis similarity is a non – metric coefficient particularly common in ecology for the quantitative and qualitative standardized variables (Bray and Curtis, 1957). CA according to Bray Curtis, which was applied in order to classify the investigated dam lakes according to water quality characteristics, and Similarity and Distance Index (SDI) according to Bray Curtis, which was applied in order to determine the similarity coefficients of reservoirs, were applied to detected data by using PAST statistical software.

Figure 1. Reservoirs of Edirne Province and selected stations

3. RESULT AND DISCUSSION

The detected water quality parameters in Sultanköy, Altınyazı, Süloğlu and Kadıköy Dam Lakes and some national – international limit values are given in Table 2.

Table 2. Results of detected parameters and some limit values

Limit Values and the Results of Present Study		Parameters												
		pH	EC (mS/cm)	[a]TDS (mg/L)	Salinity (‰)	Tur (NTU)	NO_3 (mg/L)	NO_2 (mg/L)	SO_4 (mg/L)	[b]PO_4 (mg/L)	COD (mg/L)	TC (mg/L)	TIC (mg/L)	TOC (mg/L)
***Turkish Regulations Water Quality Classes** (2012)	**I. Class** (Very Clean)	6.5-8.5	400	500	-	-	5	0.002	200	0.02	25	-	-	5
	II. Class (Less Contaminated)	6.5-8.5	1000	1500	-	-	10	0.01	200	0.16	50	-	-	8
	III. Class (Much Contaminated)	6.0-9.0	3000	5000	-	-	20	0.05	400	0.65	70	-	-	12
	IV. Class (Extremely Contaminated)	Out of 6.0-9.0	>3000	>5000	-	-	>20	>0.05	>400	>0.65	>70	-	-	>12
Drinking Water Standards	**TS266** (2005)	6.5-9.5	2500	-	-	5	50	0.5	250	-	-	-	-	-
	EC (2007)	6.5-9.5	2500	-	-	-	50	0.5	250	-	-	-	-	-
	WHO (2011)	-	-	-	-	-	50	0.2	-	-	-	-	-	-
EC Fish Health Standards (2006)	**EC/C** (Cyprinides)	6-9		25	-	-	-	0.03	-	-	-	-	-	-
	EC/S (Salmonides)	6-9	-	25	-	-	-	0.01	-	-	-	-	-	-
Dam Lakes of Edirne Province	**Süloğlu**	**9.59** IV. Class	277 I. Class	132 I. Class	0.13	3.86	0.8 I. Class	0.005 II. Class	20 I. Class	0.06 II. Class	27.2 II. Class	28.7	25.7	2.98 I. Class
	Sultanköy	**8.98** III. Class	623 II. Class	303 I. Class	0.31	28.9	0.7 I. Class	**0.028** III. Class	79 I. Class	0.02 II. Class	18.3 I. Class	42.5	41.8	0.696 I. Class
	Altınyazı	8.26 I. Class	680 II. Class	325 I. Class	0.33	14.3	0.8 I. Class	**0.012** III. Class	95 I. Class	0.01 I. Class	13.1 I. Class	56	37.6	**18.4** IV. Class
	Kadıköy	8.41 I. Class	629 II. Class	306 I. Class	0.31	3.97	1.3 I. Class	**0.017** III. Class	88 I. Class	0.03 II. Class	9.31 I. Class	56.3	34.4	**21.9** IV. Class

[a]Turkish Regulations, 2004; [b]Uslu and Türkman, 1987; *III. – IV. Class water qualities are given in bold
TS266 – Turkish Standards Institute; EC – European Communities; WHO – World Health Organization
(III – IV. Class water qualities were given in bold)

According to the Water Pollution Control Regulation criteria in Turkey (20
04; 2012), all the investigated reservoirs have I. – II. Class water quality in terms of electrical conductivity, TDS, nitrate, sulphate, phosphate and COD parameters; Sultanköy, Altınyazı and Kadıköy Dam Lakes have III. Class water quality in terms of nitrite parameter; Süloğlu and Sultanköy Dam Lakes have IV. Class water quality in terms of pH parameter; and Altınyazı and Kadıköy Dam Lakes have IV. Class water quality in terms of TOC parameter. Also the pH value recorded in Süloğlu Dam Lake was higher than the drinking water limit reported by the Turkish Standards Institute and Europinion Communities (TS266, 2005; EC, 2007); TDS values recorded in all the reservoirs (for cyprinids and salmonids) and nitrite values recorded in Sultanköy, Altınyazı and Kadıköy Dam Lakes (for salmonids) were significantly higher than the fish health limits reported by the Europinion Communities (EC, 2006).

Organic carbon is known as the energy substrate for many microorganisms and various natural and anthropogenic activities result in the presence of dissolved organic carbon in water. Consumption of organic carbon by microbiologic activity in water contributes to the problem of inadequate dissolved oxygen (Mostofa et al., 2005; Chou et al., 2010). Nitrite that is known as an intermediate product in the biological oxidation process reaching from ammonium to nitrate can reach to high concentrations in low – oxygen and organically contaminated water. Fertilizers using intensively in agricultural activities, municipal wastewater discharges from settlement areas are significantly contaminating the freshwater bodies organically and they are known as the most important factors on increasing the amount of nitrite in water (Wetzel, 2001; Manahan, 2011; Tokatlı, 2015). Edirne Province of Turkey known as agriculture city contained rich soil and much freshwater resources. The detected quite high nitrite and TOC levels in almost all the reservoirs could be sourced from agricultural applications and settlement areas.

Cluster Analysis (CA) is an important group of multivariate statistical techniques that helps to classify the investigated areas and it is widely used in environmental studies. CA provides valuable and easy explaining data and helps in the interpretation of complex data matrices for a better understanding of water quality and ecological status of the aquatic system and is being used in large numbers of countries in order to classify many different freshwater habitats (Tabachnick and Fidell, 1996; Tokatlı et al., 2013; Tokatlı, 2014; Tokatlı et al., 2014b; Ruzdjak and Ruzdjak, 2015; Tokatlı, 2017). In this study, CA was applied to detected data to classify the reservoirs according to water quality characteristics. The diagram of CA calculated by using psychochemical data is given in Figure 2. According to the results of CA, three statistically significant clusters were formed: Cluster 1 (C1) corresponded to Süloğlu Dam Lake that was classified as the unpolluted reservoir of Edirne; Cluster 2 (C2) corresponded to Kadıköy and Altınyazı Dam Lakes that were classified as the moderately polluted reservoirs of Edirne; Cluster 3 (C3) corresponded to Sultanköy Dam Lake that was classified as the polluted reservoir of Edirne. Maximum similarity was observed between Kadıköy and Altınyazı Dam Lakes (95%) and minimum similarity was observed between Süloğlu and Altınyazı Dam Lakes (57%) (Table 3).

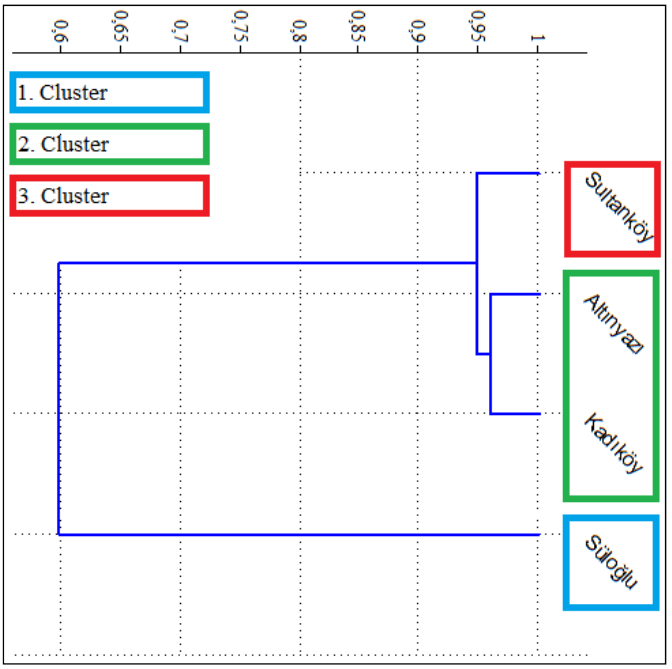

Figure 2. Diagram of CA

Table 3. Similarity coefficients of investigated dam lakes

*	**Süloğlu**	**Sultanköy**	**Altınyazı**	**Kadıköy**
Süloğlu	1			
Sultanköy	0.61613	1		
Altınyazı	**0.57692**	0.93695	1	
Kadıköy	0.60336	0.95858	**0.95896**	1

*Highest and lowest similarities are given in bold

4. CONCLUSION

In this study, water quality of Sultanköy, Altınyazı, Süloğlu and Kadıköy Dam Lakes located in the Edirne Province were evaluated by investigating some psychochemical water quality parameters. According to data observed, organic contents in water of almost all the reservoirs of Edirne Province were detected in quite high levels. According to the results of CA, three clusters of similar water quality characteristic were identified and the reservoirs were classified as unpolluted (Süloğlu Dam Lake), moderetaly polluted (Altınyazı and Kadıköy Dam Lakes) and polluted (Sultanköy Dam Lake). As a result of this study, it can be concluded that reservoirs of Edirne Province are under negative effect of a significant agricultural pressure and this situation cause to reduce the water quality. Nitrogenous and phosphorus are important plant nutrient and may limit the growth of agricultural crop, but it may also cause significant health problems in plants, animals and human, if exposed it in large amounts. In order to provide the sustainability of these reservoirs in terms of availability on a healthy use by local people, organic contents including mainly nitrogenous and phosphate concentrations of the dam lakes originated from agricultural and domestic applications must be reduced as soon as possible.

REFERENCES

[1] Bray, J. R. and Curtis, J. T. (1957). An ordination of the upland forest communities of Southern Wisconsin. Ecological Monographs 27:325–349.

[2] Chou W. L., Wang C. T., Hsu C. W., Huang K. Y., Liu T. C. (2010). Removal of total organic carbon from aqueous solution containing polyvinyl alcohol by electrocoagulation technology, Desalination 259: 103–110.

[3] EC (European Communities) (2006). EC of the European Parliament and of the council of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life. Directive 2006/44.

[4] EC (European Communities) (2007). European Communities (drinking water) (no. 2), Regulatıons 2007, S.I. No. 278 of 2007.

[5] Dixon W., Chiswell B. (1996). Review of aquatic monitoring program design. Water Research, 30: 1935–1948.

[6] http://www2.dsi.gov.tr/

[7] Köse E., Tokatlı C., Çiçek A. (2014). Monitoring Stream Water Quality: A Statistical Evaluation. Polish Journal of Environmental Studies, 23 (5): 1637-1647.

[8] Manahan S. E. (2011). Water Chemistry: Green Science and Technology of Nature's Most Renewable Resource. Taylor & Francis Group, CRC Press, 398 pages.

[9] Mostofa K. M. G., Hond Y., Sakugawa H. (2005). Dynamics and optical nature of fluorescent dissolved organic matter in river waters in Hiroshima Prefecture, Japan, Geochem. J. 39: 257–271.

[10] Ruzdjak A. M., Ruzdjak D. (2015). Evaluation of river water quality variations using multivariate statistical techniques: Sava River (Croatia): A Case Study. Environmental Monitoring and Assessment, vol. 187, no. 4, pp. 1–14.

[11] 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.

[12] 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.

[13] Tabachnick B. G., Fidell L. S. (1996). Using multivariate statistics (3rd ed.). New York: Harper Collins College Publishers.

[14] 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.

[15] Tokatlı, C. (2014). Drinking Water Quality of a Rice Land in Turkey by a Statistical and GIS Perspective: Ipsala District. Polish Journal of Environmental Studies, 23 (6): 2247-2258. (Science Citation Index Expanded)

[16] Tokatlı C., Çiçek A., Köse E. (2013). Groundwater Quality of Türkmen Mountain (Turkey). Polish Journal of Environmental Studies, 22 (4), 1197-1208.

[17] Tokatlı C., Çiçek A., Emiroğlu Ö., Arslan N., Köse E., Dayıoğlu H. (2014). Statistical Approaches to Evaluate the Aquatic Ecosystem Qualities of a Significant Mining Area: Emet Stream Basin (Turkey). Environmental Earth Sciences, 71 (5): 2185-2197.

[18] 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 Journal of Environmental Studies, 23 (5): 1741-1751.

[19] 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.

[20] Tokatlı, C. (2017). Bio – Ecological and Statistical Risk Assessment of Toxic Metals in Sediments of a Worldwide Important Wetland: Gala Lake National Park (Turkey). Archives of Environmental Protection, 43 (1): 34-47.
[21] TS 266 (2005). Sular-İnsani tüketim amaçlı sular. Türk Standartları Enstitüsü, ICS 13.060.20.
[22] Turkish Regulations (2004). Yüzeysel Su Kalitesi Yönetimi Yönetmeliği, 31 Aralık Cuma tarihli Resmi Gazete, Sayı: 25687, http://suyonetimiormansu.gov.tr.
[23] Turkish Regulations (2012). Yüzeysel Su Kalitesi Yönetimi Yönetmeliği, 30 Kasım 2012 tarihli Resmi Gazete, Sayı: 28483, http://suyonetimiormansu.gov.tr.
[24] Wetzel R. G. (2001). Limnology: Lake and River Ecosystems. Elsevier Academic Press, 1006 pages.
[25] WHO (World Health Organization) (2011). Guidelines for Drinking-water Quality. World Health Organization Library Cataloguing-in-Publication Data, NLM classification: WA 675.