Sigma J Eng & Nat Sci 38 (1), 2020, 393-402

Sigma Journal of Engineering and Natural Sciences
Sigma Mühendislik ve Fen Bilimleri Dergisi

Research Article

APPLICATION OF WATER QUALITY INDEX FOR DRINKING PURPOSES IN DAM LAKES: A CASE STUDY OF THRACE REGION

Cem TOKATLI*[1]

[1]*Trakya University, Department of Laboratory Technology, EDIRNE;* ORCID: 0000-0003-2080-7920

Received: 03.04.2019 Revised: 27.08.2019 Accepted: 27.01.2020

ABSTRACT

Thrace Region is located in the north – west part of Marmara Region of Turkey and has very large agricultural lands because of contained quite rich soil and many freshwater resources. Altınyazı, Karaidemir, Kayalıköy, Kırklareli, Sultanköy and Süloğlu Dam Lakes are located in Thrace Region and they were constructed by DSİ (State Water Works) in order to provide irrigation and drinking water and flood protection. The aim of this study was to determine a total of 25 essential and toxic element accumulations in water of these significant reservoirs (Li, Be, B, Na, Mg, Al, K, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Sr, Mo, Cd, Sb, Ba, Tl and Pb) and apply the Weighted Arithmetic Water Quality Index (WAWQI) in order to evaluate the water quality in terms of drinking purposes. Cluster Analysis (CA) was also used to classify the investigated elements and stations in terms of similar characteristics. Water samples were collected in spring season (rainy) of 2018 from 15 stations and element accumulations were investigated by using an ICP-MS. According to results of elemental CA, 4 statistically significant clusters were formed in terms of similar elemental densities, which were named as "most intense elements", "high-moderate intense elements", "low-moderate intense elements" and "rarest elements". According to results of locational CA, 2 statistically significant clusters were formed in terms of similar water quality characteristics, which were named as "more polluted locations" and "less polluted locations". According to the results of WAWQI, the reservoirs has "A grade" water quality and the values of overall WAWQI were within the permissible limits (<100). But the Qi values of selenium were found as over the permissible limits and the risk sequence of the elements in water of the reservoirs as follows: Se > As > Cr > B > Mo > Ba > Ni > Pb > Cd > Mn > Cu in general.
Keywords: Thrace region reservoirs, macro – micro elements, water quality index.

1. INTRODUCTION

Thrace Region, which is situated in the north – west part of Turkey, is one of the most important agricultural areas of Turkey and has very fertile soils. Although the Thrace Region covers only a 3% part of Turkey, 15% of the total population of the country lives in this region. Intensive agricultural activities, increase of the population parallel to the industrialization and opening the farmlands to urbanization cause significant environmental problems like polluting the soil and water resources with toxic elements and other harmful substances (Coşkun et al., 2006, Özler and Aydın, 2008; Tokatlı and Baştatlı, 2016). Altınyazı, Karaidemir, Kayalıköy, Kırklareli,

* Corresponding Author: e-mail: tokatlicem@gmail.com, tel: (284) 616 35 34

Sultanköy and Süloğlu Dam Lakes are located in Thrace Region and being effected from especially agricultural contamination.

Karaidemir Dam Lake is one of the most important reservoirs of Tekirdağ Province and it is located on the southern section of Ergene River Basin. It was constructed between the dates of 1975 – 1983 by DSİ (State Water Works) on the Poğaça Stream in order to provide irrigation and drinking water and also flood protection for the local settlements. The volume of this reservoir at a normal water elevation is about 120 hm^3 and the lake area at a normal water level is 16 km^2 (http://www2.dsi.gov.tr/).

Kayalıköy and Kırklareli Dam Lakes are the most important reservoirs of Kırklareli Province and they are located on the northern section of Ergene River Basin. Kayalıköy and Kırklareli Dam Lakes, which have an irrigation area of 14716 ha – 9050 ha respectively, were constructed by DSİ with body fill type of rock in order to provide irrigation and drinking water and also flood protection and the body volumes of these reservoirs are 1528 dam^3 – 1838 dam^3 respectively. Kayalıköy Dam Lake has a volume of 150 hm^3 at a normal water elevation and lake area of 10 km^2 at a normal water level and it was constructed between the dates of 1975 – 1986 on the Teke Stream. Kırklareli Dam Lake has a volume of 112 hm^3 at a normal water elevation and lake area of 6 km^2 at a normal water level and it was constructed between the dates of 1985 – 1997 on the Şeytandere Stream (http://www2.dsi.gov.tr/).

Altınyazı, Sultanköy and Süloğu Dam Lakes are the most important reservoirs of Edirne Province and they are located on the western section of Ergene River Basin. The irrigation areas of these reservoirs are 7730 ha, 7773 ha and 3986 ha and the body volumes of the reservoirs are 524 dam^3, 1762 dam^3 and 1320 dam^3 respectively. They were constructed by DSİ with body fill types of soil (Altınyazı and Sultanköy Dam Lakes) and rock (Süloğlu Dam Lake) in order to provide irrigation and drinking water and flood protection. Altınyazı Dam Lake has a volume of 31 hm^3 at a normal water elevation and lake area of 4 km^2 at a normal water level and it was constructed in 1970 on the Basamaklar Stream. Sultanköy Dam Lake has a volume of 26 hm^3 at a normal water elevation and lake area of 3 km^2 at a normal water level and it was constructed in 1996 on the Manastır Stream. Süloğlu Dam Lake has a volume of 33 hm^3 at a normal water elevation and lake area of 3 km^2 at a normal water level and it was constructed in 1981 on the Süloğlu Stream (http://www2.dsi.gov.tr/).

Water quality indices, which become important parameters for the assessment and management of both surface and ground water, are effective vehicles to obtain information on the quality of investigated water to the concerned citizens and policy makers. Weighted Arithmetic Water Quality Index (WAWQI), which may defined as a rating reflecting the composite influence of different water quality parameters, is one of the most commonly used drinking water quality indices (Tyagi et al., 2013; Akter et al., 2016; Mukatea et al., 2019). The aim of this study was to determine the essential and toxic element concentrations in water of most significant artificial lentic habitats of Thrace Region and evaluate the detected data by using Arithmetic Water Quality Index.

2. MATERIALS AND METHODS

2.1. Study area and collection of samples

Water samples were collected from 15 stations selected on the reservoirs in rainy (spring) season of 2018. Topographic map of Thrace Region and Altınyazı, Karaidemir, Kayalıköy, Kırklareli, Sultanköy and Süloğlu Dam Lakes and selected stations on the reservoirs are given in Figure 1.

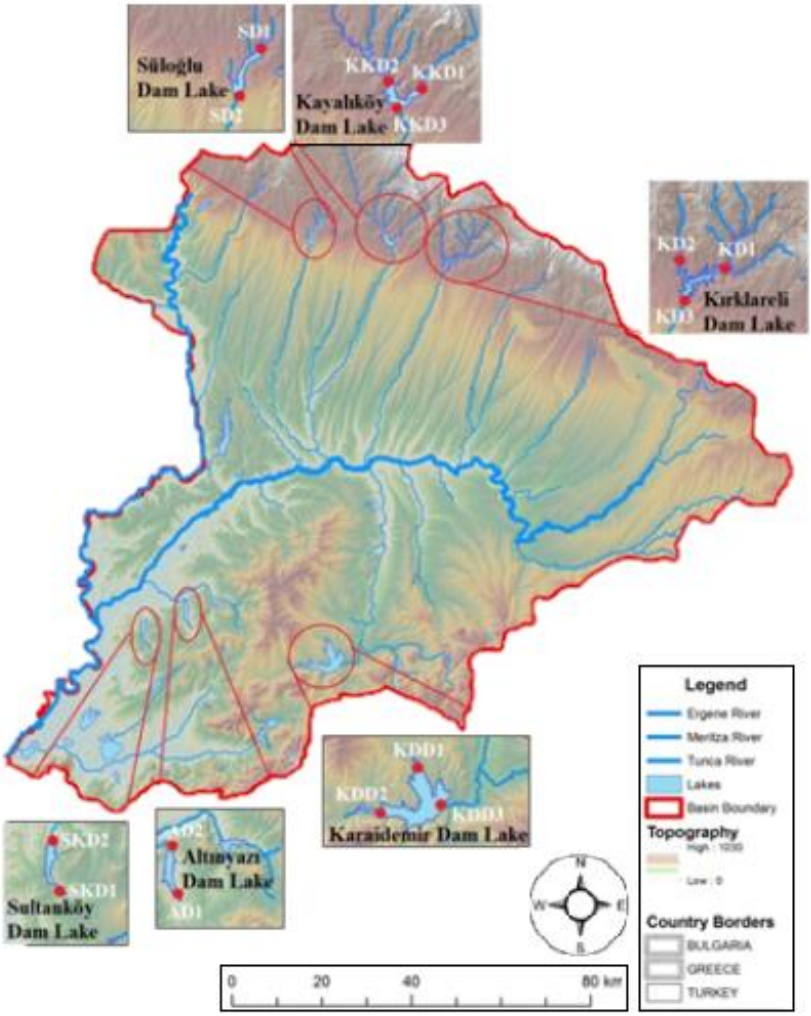

Figure 1. Topographic map of Thrace Region, Dam Lakes and selected stations

2.2. Chemical analysis

Water samples of one liter were adjusted to pH 2 by adding 2 ml of HNO_3 into each. Afterwards, all 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. The element levels in water samples were determined by using the "Agilent 7700 xx" branded Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) device in Trakya University Technology Research and Development Application and Research Center (TÜTAGEM). The center has an international accreditation certificate within the scope of TS EN / ISO IEC 17025 issued by TÜRKAK (representative of the World Accreditation Authority in Turkey). The element analyses were recorded as means triplicate measurements (APHA, 1992; EPA, 1998; 2001).

2.3. Statistical analysis

Cluster Analysis (CA) according to Bray Curtis was applied to detected data in order to classify the investigated macro and micro elements according to their densities and in order to classify the investigated locations according to their similar water quality characteristics by using the "PAST" statistical package program.

2.4. Calculation of Weighted Arithmetic Water Quality Index

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the investigated water quality parameters (Brown et al., 1972). The calculation of WAWQI was made by using the following formula:

$$\text{WAWQI} = \sum QiWi / \sum Wi$$

The quality rating scale (Qi) for each parameter is calculated by using the following formula:

$$Qi = 100[(Vi - Vo)/(Si - Vo)]$$

Where;

Vi is estimated concentration of i^{th} parameter in the analyzed water,

Vo is the ideal value of this parameter in pure water (Vo= 0 in general),

Si is recommended standard value of i^{th} parameter.

The unit weight (Wi) for each the water quality parameter is calculated by using the following formula:

$$Wi = K/Si$$

Where;

K = proportionality constant and can also be calculated by using the following formula:

$$K = \frac{1}{\sum(1/Si)}$$

The rating of water quality according to WAWQI is given in Table 2 (Brown et al., 1972).

Table 2. Water Quality Rating as per WAWQI Method (Brown et al., 1972)

WAWQI Value	Rating of Water Quality	Usage Possibilities	Grading
0 – 25	Excellent water quality	Drinking, irrigation, industrial	A
25 – 50	Good water quality	Drinking, irrigation, industrial	B
50 – 75	Poor water quality	Irrigation, industrial	C
75 – 100	Very Poor water quality	Irrigation	D
> 100	Unsuitable for drinking purpose	Proper treatment is required before use	E

3. RESULTS

Macro and micro element concentrations detected in water of reservoirs located in the Thrace Region are given in Table 2. According to the results of elemental CA, a total of 4 clusters were determined. 1. Cluster was formed by the elements of Na, Ca, Mg and K (most intense elements); 2. Cluster was formed by the elements of Al, Fe, Sr, B and Ba (high-moderate intense elements); 3. Cluster was formed by the elements of V, Zn, Cr, Mo, Ni, Se, Li, Mn, Cu and As (low-moderate intense elements); 4. Cluster was formed by the elements of Co, Pb, Sb, Cd, Tl and Be (rarest elements) (Figure 2). According to the results of locational CA, a total of 2 clusters were determined. 1. Cluster was formed by the stations of KDD1, KDD2, KDD3, AD1, AD2, SKD1

and SKD2 (Southern Dam Lakes; more polluted locations); 2. Cluster was formed by the stations of KD1, KD2, KD3, KKD1, KKD2, KKD3, SD1 and SD2 (Northern Dam Lakes; less polluted locations) (Figure 2).

Table 2. Element accumulations in water of dam lakes

Elements	Northern Dam Lakes								Southern Dam Lakes						
	Süloğlu		Kırklareli			Kayalıköy			Karaidemir			Altınyazı		Sultanköy	
(ppb)	SD1	SD2	KD1	KD2	KD3	KKD1	KKD2	KKD3	KDD1	KDD2	KDD3	AD1	AD2	SKD1	SKD2
Li	3.287	3.913	3.061	2.720	2.640	2.577	3.444	2.415	12.134	12.205	12.766	11.488	11.458	8.290	8.149
Be	0.080	0.074	0.049	0.048	0.052	0.043	0.065	0.038	0.052	0.040	0.049	0.044	0.030	0.050	0.033
B	7.34	0.85	3.43	5.48	1.27	5.11	3.00	3.24	112.40	89.49	90.63	66.60	64.53	57.54	47.76
Na	22681	17994	14870	17115	15327	17238	20720	20341	71168	51789	50855	42949	43756	45821	53376
Mg	7794	7219	15436	9356	8579	6524	8464	6589	35914	27957	26015	28714	29863	16049	16265
Al	678.29	1197.53	1.05	11.85	12.36	20.30	8.83	22.30	3.23	20.34	24.29	2.17	2.19	3.00	4.71
K	3519	3370	1854	1971	1920	3109	3650	2942	6553	6211	6258	4536	4441	5836	5685
Ca	14264	13889	32887	19518	18065	14580	20604	15287	39227	36771	33692	35579	37173	27434	31649
V	3.240	3.839	1.967	1.899	1.919	2.161	3.062	2.253	2.924	3.964	3.847	2.701	2.720	3.380	4.117
Cr	4.270	4.760	4.426	3.910	3.795	3.679	3.951	3.698	4.865	4.560	4.516	4.726	4.831	4.332	4.400
Mn	5.38	6.91	1.02	1.38	2.10	5.93	7.12	8.31	0.58	0.58	0.54	0.31	0.22	0.49	0.47
Fe	495.70	783.34	92.67	99.18	94.51	104.95	101.67	118.41	122.32	122.84	115.68	102.15	108.68	89.62	98.43
Co	0.258	0.278	0.203	0.172	0.163	0.140	0.311	0.166	0.345	0.322	0.321	0.262	0.247	0.436	0.344
Ni	1.871	2.049	1.325	1.016	1.050	1.203	1.988	1.092	6.166	5.538	5.530	3.850	3.913	4.874	4.262
Cu	4.978	1.650	2.514	10.546	18.365	5.309	1.232	5.940	1.352	1.168	1.183	2.484	1.333	2.219	1.474
Zn	3.390	3.327	1.916	2.090	1.983	1.980	2.193	2.064	2.156	2.108	2.035	1.993	1.922	2.109	2.161
As	0.807	0.727	0.356	0.427	0.578	0.470	0.798	0.503	1.743	1.601	1.449	0.674	0.708	1.608	2.042
Se	10.212	10.193	9.485	10.136	9.799	9.893	10.362	10.292	11.433	10.946	10.346	9.821	9.838	9.640	9.792
Sr	79.34	77.58	54.98	56.60	55.29	103.81	149.00	111.49	427.93	410.73	380.54	369.12	384.65	222.95	246.39
Mo	4.844	4.792	4.699	4.722	4.705	4.901	5.245	4.877	5.670	5.422	5.430	4.880	4.817	5.361	5.375
Cd	0.023	0.025	0.013	0.021	0.015	0.016	0.024	0.022	0.046	0.021	0.018	0.020	0.011	0.022	0.015
Sb	0.104	0.025	0.032	0.039	0.052	0.006	0.045	0.005	0.186	0.068	0.089	0.053	0.041	0.479	0.382
Ba	37.61	27.67	17.81	18.04	19.36	23.84	38.80	24.12	65.70	39.34	39.13	24.89	24.41	43.35	35.49
Tl	0.039	0.034	0.024	0.026	0.030	0.026	0.026	0.028	0.035	0.024	0.027	0.021	0.023	0.026	0.022
Pb	0.263	0.446	0.100	0.097	0.114	0.087	0.104	0.139	0.068	0.092	0.100	0.077	0.088	0.069	0.090

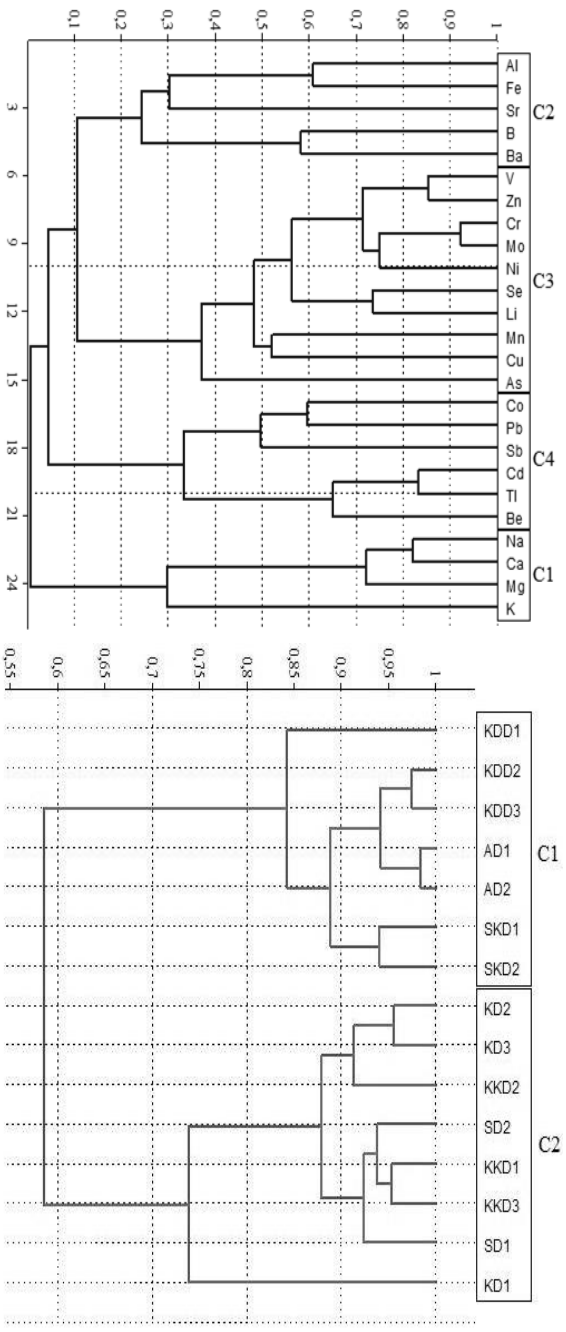

Figure 2. CA diagram of elements (left) and locations (right)

Monomial and multinomial risks of B, Cr, Mn, Ni, Cu, As, Se, Mo, Cd, Ba and Pb in water of artificial lentic habitats located in Thrace Region for all the investigated locations were determined by using Weighted Arithmetic Water Quality Index (WAWQI). The quality rating scale values (Qi), which means the results of monomial WAWQI, calculated unit weights (Wi) of investigated parameters and the data of overall WAWQI, which means the results of multinomial WAWQI are given in Table 3. The results recorded in this study revealed that although the reservoirs has "A grade" water quality and the values of overall WAWQI were within the permissible limits (<100) for the entire samples taken, quality rating scale values of selenium was not within the permissible limits (>100) almost in all the investigated locations. According to the results of Multinomial WAWQI, Karaidemir Dam Lake was found to be the most risky reservoir in terms of drinking water quality and according to the results of quality rating scale values, the risk sequence of the elements in water of the dam lakes used in the Weighted Arithmetic Water Quality Index as follows: Se > As > Cr > B > Mo > Ba > Ni > Pb > Cd > Mn > Cu in general.

Table 3. Values of quality rating scale values (Qi), unit weights (Wi) and overall WAWQI

Stations	Used Elements in WAWQI											Overall WAWQI
	B	**Cr**	**Mn**	**Ni**	**Cu**	**As**	**Se**	**Mo**	**Cd**	**Ba**	**Pb**	
	Wi											
	0.0029	0.029	0.0036	0.0207	0.0007	0.145	0.145	0.0207	0.4833	0.002	0.145	
	Qi											
SD1	1.47	8.54	1.34	2.67	0.25	8.07	102.12	6.92	0.77	5.37	2.63	**17.23**
SD2	0.17	9.52	1.73	2.93	0.08	7.27	101.93	6.85	0.82	3.95	4.46	**17.40**
KD1	0.69	8.85	0.25	1.89	0.13	3.56	94.85	6.71	0.43	2.54	1.00	**15.09**
KD2	1.10	7.82	0.34	1.45	0.53	4.27	101.36	6.75	0.69	2.58	0.97	**16.23**
KD3	0.25	7.59	0.52	1.50	0.92	5.78	97.99	6.72	0.49	2.77	1.14	**15.87**
KKD1	1.02	7.36	1.48	1.72	0.27	4.70	98.93	7.00	0.53	3.41	0.87	**15.84**
KKD2	0.60	7.90	1.78	2.84	0.06	7.98	103.62	7.49	0.80	5.54	1.04	**17.21**
KKD3	0.65	7.40	2.08	1.56	0.30	5.03	102.92	6.97	0.73	3.45	1.39	**16.64**
KDD1	22.48	9.73	0.15	8.81	0.07	17.43	114.33	8.10	1.55	9.39	0.68	**20.70**
KDD2	17.90	9.12	0.14	7.91	0.06	16.01	109.46	7.75	0.70	5.62	0.92	**19.34**
KDD3	18.13	9.03	0.14	7.90	0.06	14.49	103.46	7.76	0.60	5.59	1.00	**18.22**
AD1	13.32	9.45	0.08	5.50	0.12	6.74	98.21	6.97	0.68	3.56	0.77	**16.26**
AD2	12.91	9.66	0.06	5.59	0.07	7.08	98.38	6.88	0.36	3.49	0.88	**16.20**
SKD1	11.51	8.66	0.12	6.96	0.11	16.08	96.40	7.66	0.72	6.19	0.69	**17.38**
SKD2	9.55	8.80	0.12	6.09	0.07	20.42	97.92	7.68	0.50	5.07	0.90	**18.14**
Min	0.17	7.36	0.06	1.45	0.06	3.56	94.85	6.71	0.36	2.54	0.68	15.09
Max	22.48	9.73	2.08	8.81	0.92	20.42	114.33	8.10	1.55	9.39	4.46	20.70
Mean	7.45	8.63	0.69	4.35	0.21	9.66	101.46	7.21	0.69	4.57	1.29	17.18

4. DISCUSSION

As a result of this study, it was determined that some element concentration recorded in some reservoirs were found as quite high levels and exceed the limit values. But the majority of investigated element levels have been found to be in the range of human consumption standards, in general (TSI266, 2005; EC, 2007; WHO, 2011). It was also determined that according to the Water Pollution Control Regulation criteria in Turkey (Anonymous, 2016), water of reservoirs located in Thrace Region has I. – II. Class water quality in terms of all the investigated inorganic parameters, in general.

According to the results of Weighted Arithmetic Water Quality Index (WAWQI), the investigated dam lakes located in the Thrace Region has "A grade" water quality in general. It was also determined that the values of overall WAWQI were within the permissible limits (<100) and they were recorded between 15.09 – 20.70, which can be considered as quite low levels. But the quality rating scale values of selenium parameter was found as over the permissible limits

almost all the investigated reservoirs and they were recorded between 94.85 – 114.33, which can be considered as quite high levels.

In a study performed in Nagpur city (India), water quality index (WQI) has been calculated for different surface water resources. As a result of this study, in contrast of the results of the present study, the calculated WQI for various studied lakes showed poor water quality in summer season (Puri et al., 2011).

In a study performed in the city of Pogradec, Albania, assessment of drinking water quality was made by using the water quality index (WQI). According to the results of this research, as similar of the results of the present study, the drinking water quality in the city of Pogradec was found as "good" level (Damo and Icka, 2013).

In another study performed in Lake Taihu Basin, China, water qualities of the rivers located in the basin were evaluated based on water quality index (WQI) method. According to the results of this study, as considerably higher than the values obtained in the present study, the average WQI value during the research period was stated as 59.33 and the water quality was found as "moderate" quality (Wu et al., 2018).

The selenium accumulations recorded in water of investigated dam lakes were between values of 9.48 – 11.43 ppb and the average selenium accumulations in water samples were recorded as 10.14 in the region. The detected selenium concentrations in almost all the investigated locations in almost all the investigated reservoirs exceeded the drinking water limit of 10 ppb specified by Turkish Standards Institute (TSI266, 2005), European Communities (EC, 2007) and World Health Organization (WHO, 2011). In water of artificial lentic habitats of Thrace Region, selenium contents of about 53.3% of investigated locations were found to be as higher than the limit of 10 ppb. Selenium is known to be released to the environment by means of sewage effluent, agricultural runoff and industrial waste water (ATSDR, 2003). The reason of detected quite high selenium contents in water samples may be sewage wastes originated from settlement areas on the region. It should also be noted that people living in rural areas may be at a higher risk of selenium exposure than people living in urban regions. Because rural people tend to consume a larger proportion of locally grown foods, whereas urban people tend to consume foods grown over a wider geographic area (ATSDR, 2003). Therefore the selenium accumulations in water of these rural areas must be kept under control in order to protect the health of local people living in Thrace Region.

Thrace Region of Turkey is known as an "agricultural city", because of its quite productive soil and quite rich ground – surface water resources. The region is also known as an "industrial city", because of numbers of industrial plants located on its territory (Tokatlı, 2014; 2015; 2017; 2018). Therefore, agricultural runoff originated from intensive cultivation applications conducted almost all around the region, and industrial contamination originated from intensive industrial placement on especially Çorlu and Çerkezköy Districts and transported by means of Ergene River are also thought to be the main pollution factors for these significant lentic aquatic habitats of the region. In this study, trace and toxic element accumulations in water of reservoirs located in the south part of the Thrace Region, where is located on the downstream of Ergene River Basin, were found to be significantly higher that detected in the north part of the region, where has no direct connection with the Ergene River. Results of locational CA also support this assumption that 2 statistically significant clusters were formed in terms of similar water quality characteristics in the present application and the reservoirs located in the northern and southern parts of the region were found in the separate clusters.

5. CONCLUSIONS

In this study, some essential and toxic element concentrations in water of most significant reservoirs located in Thrace Region of Turkey were investigated. Cluster Analysis (CA) and Weighted Arithmetic Water Quality Index (WAWQI) were used to evaluate the detected data. CA

was grouped 25 macro and micro elements into 4 clusters of similar accumulation characteristics; "Most intense elements", "High-moderate intense elements", "Low-moderate intense elements" and "Rarest elements". CA was also grouped 15 stations of 6 dam lakes into 2 clusters of similar water quality characteristics; "More polluted locations" and "Less polluted locations". According to detected data, selenium contents detected in almost all the investigated stations exceeded the drinking water standards and selenium element was found to be as the most risky element in water of reservoirs. It was also determined that the dams located in the south part of the Thrace Region were found to be more polluted than the dams located in the north part and Karaidemir Dam Lake was found to be as the most risky reservoir in the region.

In conclusion, although levels of some elements in reservoirs were determined as quite high levels and exceed the limit values, the majority of investigated toxic element contents in the region have been found to be in the range of human consumption standards. The detected data reveals that agricultural runoff and the industrial discharges are the main risk factors for these artificial lentic habitats located in Thrace Region.

Acknowledgement

The authors would like to thank for the financial and technical supports supplied by Trakya University, Turkey. This investigation has been supported by the project numbered as 2017/211 accepted by Trakya University, Commission of Scientific Research Projects.

REFERENCES

[1] Anonymous (2016). Yüzeysel Su Kalitesi Yönetimi Yönetmeliği. 10 Ağustos 2016 Tarih ve 29737 Sayılı Resmi Gazete. Orman ve Su İşleri Bakanlığı, Ankara, 28 s.

[2] APHA (American Public Health Association) (1992). Standard methods for the examination of water and wastewater. In A.E. Greenberg, A.E., Clesceri, L.S. and Eato, A.D. (eds.) American Public Health Association. 18th ed.,Washington, U.S.A.

[3] ATSDR (Agency for Toxic Substances and Disease Registry) (2003). Toxicological Profile for Selenium. Atlanta, GA: U.S. Department of Health and Human Services.

[4] Akter, T., Jhohura, F. T., Akter, F., Chowdhury, T. R., Mistry, S. K., Dey, D., Barua, M. K., Islam, M. A., Rahman, M. (2016). Water Quality Index for Measuring Drinking Water Quality in Rural Bangladesh: A Cross-Sectional Study. Journal of Health, Population and Nutrition, 35:4.

[5] Brown, R. M., Mcclelland, N. I., Deınınger, R. A., O'connor, M. F. (1972). A Water Quality Indexcrashing the Physiological Barrier. Indic Environ Qual, 1, 173–182.

[6] Coşkun, M., Steinnes, E., Viladimirovna, M., Torill, F., Sjobakk, E., Demkina, S. (2006). Heavy Metal Pollution of Surface Soil in the Thrace Region, Turkey. Environmental Monitoring and Assessment, 119 (1–3): 545–556.

[7] Damo, R., Icka., P. (2013). Evaluation of Water Quality Index for Drinking Water. Pol. J. Environ. Stud., 22 (4): 1045-1051.

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

[9] EPA (Environmental Protection Agency) METHOD 3051. (1998). Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils.

[10] EPA (Environmental Protection Agency) METHOD 200.7. (2001). Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry.

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

[12] Mukatea, S., Wagha, V., Panaskara, D., Jacobs, J. A., Sawantc, A. (2019). Development of New Integrated Water Quality Index (IWQI) Model to Evaluate the Drinking Suitability of Water. Ecological Indicators, 101: 348-354.

[13] Özler, H. M., Aydın, A. (2008). Hydrochemical and Microbiological Quality of Groundwater in West Thrace Region of Turkey. Environmental Geology, 54 (2): 355–363.

[14] Puri, P. J., Yenkie, M.K.N., Sangal, S.P., Gandhare, N.V., Sarote, G. B., Dhanorkar, D. B. (2011). Surface Water (Lakes) Quality Assessment in Nagpur City (India) Based On Water Quality Index (WQI). Rasayan J. Chem., Vol.4 (1): 43-48.

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

[16] 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.

[17] 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.

[18] Tokatlı, C. (2018). Drinking Water Quality Assessment in Villages Located in Meriç River Basin (Edirne, Turkey). Sigma Journal of Engineering and Natural Sciences, 36 (3): 871-886.

[19] Tokatlı, C., Baştatlı, Y. (2016). Trace and Toxic Element Levels in River Sediments. Polish Journal of Environmental Studies, 25 (4): 1715-1720.

[20] Tyagi, S., Sharma, B., Singh, P., Dobhal, R. (2013). Water Quality Assessment in Terms of Water Quality Index. American Journal of Water Resources, 1(3):34–8.

[21] WHO (World Health Organization) (2011). Guidelines for Drinking-water Quality. World Health Organization Library Cataloguing-in-Publication Data, NLM classification: WA 675.

[22] Wu, Z., Wang, X., Chen, Y., Cai,Y., Deng, J (2018). Assessing River Water Quality Using Water Quality Index in Lake Taihu Basin, China. Science of the Total Environment, 612: 914–922.