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Research Article

Assessment of Water Quality Parameters on Uzuncayır Dam Lake Using Multivariate Statistical Analysis

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Abstract

Our aim was to determine at monthly variations physico-chemical characteristics of the water of Uzunçayır Dam Lake, Tunceli. Water samples were obtained from ten chosen stations during 2013 May- 2014 March. Data obtained were evaluated by using multivariate statistical analysis (cluster and principal component analysis). Water temperature, pH, DO, conductivity, and salinity of Uzuncayır Dam Lake were within desirable limits. The analysis showed that the Dam Lake has become an oligotrophic lake due to the high level of phosphate. Principal components (PCA) analysis revealed in two different clusters to the similarities among the stations reflected different physico-chemical properties and the level of pollution in the Dam Lake. Principal components analysis (PCA) revealed in two different clusters to the similarities among the stations which were reflected different physico-chemical properties and the level of pollution in the Dam Lake. Three potential factors were determined the explanation of 100% of the total variation of the data. In component 1, 17.7 % of all variation had Mg, NH_4 and NO_2. The component 2 and 3 analyses showed that 34.95 % of all variation stem from agricultural drainage and nutrient, from physical parameters of 68.2 %, respectively. In the analyses of cluster, one group (10 stations) was found as affected directly from the activities of domestic and agricultural land. Because of the high pH and high electrical conductivity and total solids contents which were the results of the high content of dissolved anions and cations, Uzunçayır Dam Lake is defined as a hard water lake. According to the Surface Water Quality Management (A and B group), it was concluded that Uzunçayır Dam Lake had high quality, slightly contaminated and the appropriate structure for many activities such as agricultural irrigation, drinking water supply, trout and other fish production

***Keywords*:** Uzunçayır Dam Lake, Principal components (PCA) and Cluster (CA) analyses, water quality.

Öz

Çok Değişkenli İstatistik Analizi İle Uzunçayır Baraj Gölü Su Kalitesi Parametrelerinin Değerlendirilmesi

Bu çalışmada, Uzunçayır Baraj Gölü (Tunceli)'nün fiziko-kimyasal parametrelerini aylık periyotlarda belirlemeyi amaçladık. 2013 Mayıs - 2014 Mart periyodunca 10 istasyondan su örnekleri temin edildi. Elde edilen veriler çok değişkenli istatistiksel analiz yöntemleri (küme ve temel bileşenler analizi) ile değerlendirildi.Su sıcaklığı, pH, DO, iletkenlik ve tuzluluk Uzunçayır Baraj Gölü için istenen sınırlar kapsamındadır. Analiz sonuçları, bu baraj gölünün yüksek fosfat değerlerinden dolayı oligotrofik bir yapıya sahip olduğunu göstermiştir. Temel bileşenler analizi (PCA) göre Uzunçayır Baraj Gölü'nde farklı kirlilik seviyesi ve fiziko kimyasal özellikler gösteren istasyonlar arasındaki benzerlikler iki farklı küme halinde ortaya çıkmıştır. Verilerdeki %100 değişimi gözler önüne koyan 3 potansiyel faktör tespit edilmiştir. 1. bileşende toplam değişimin %17,7'si Mg^{2+}, NH_4^+ ve NO_2^-den kaynaklanmaktadır. 2. ve 3 bileşenlerin

analizleri ise toplam değişimin %34,95'i tarımsal drenaj ve nutrientten; %68,2'si fiziksel parametrelerden ileri gelmektedir. Grup analizleri sonuçlarına göre 10 istasyonun yerel aktivite ve tarımsal alanlardan direk olarak etkilendiği bulunmuştur. Uzunçayır baraj gölü yüksek orandaki çözünmüş anyon ve katyonların sonucu olarak sahip olduğu toplam katı içerdiği, yüksek elektrik geçirgenliği ve yüksek pH'ından dolayı sert su gölü olarak adlandırılmaktadır. Yüzey suyu kalite yönetimine (A ve B Grupları) göre, Uzunçayır Baraj Gölü'nün yüksek kaliteli, hafif kontamine olduğu, tarımsal sulama, içme suyu desteği ile alabalık ve diğer balık türleri için uygun olduğu sonucuna varılmıştır.

Anahtar Kelimeler: Uzunçayır Dam Lake, Temel Bileşenler (PCA) and Küme (CA) analizleri, su kalitesi.

Introduction

Hydrosphere nearly consists of sea (97.2 %) and freshwater (2.8 %), including oceans, seas, rivers, lakes and underground waters (Bathusha and Saseetharan, 2006; Sinha et. al., 2011). Quality of freshwaters, being small part of it is a global problem nowadays, because of thought that the water quality is major factor affecting both humans and animals. When performance of water quality is enough quality and amount, health of plants, animals and humans increases in parallel.

Surface water quality of in an area effects usually with both natural events (such as climatic changes) and anthropogenic sources is stable pollutant sources (Singh et al., 2004; Vega et. al., 1996; Wu and Wang, 2007). They are main factors to determine the human activities, chemical usage in these fields and agriculture, soil erosion, wastewater, atmospheric pollution, qualities of surface and underground waters (Niemi, et. al., 1990). Retaining water for agricultural or other different purposes; increasing of organic materials together with urbanizing (Sickman et. al., 2007; Mutlu, et. al., 2016) and especially over increasing of phosphor and other nutrients with usage of fertilizers in agriculture causes water pollution (Easton et. al., 2007). Thereby, negative effects on fish sources, deaths in communities of benthic organisms, decreasing in species number and microbial growth and death with decreasing of oxygen supply arise out with over increasing of nutrients and impaired water quality (Treseder, 2008).

The multidimensional data become considerably popular in environmental researches purposing monitoring and measurement of some parameters. Factor analysis (FA) / Principal Component Analysis (PCA) consequentially using to determine the sources explaining kinds of multidimensional data analyses affecting water quality and water systems, is cluster analysis (CA) (Andrade, et al., 2008; Helena et. al., 2000; Singh et. al., 2004; 2005). Applications of multivariate statistical techniques as PCA and CA are using to determine ecologically the pollution in environmental ecosystem (Vega et al., 1998; Adams et al., 2001; Lee et al., 2001; Wunderlin et al., 2001; Reghunath et al., 2002; Simeonova et al., 2003; Simeonov et al., 2004).

Uzuncayır Dam is located on the Munzur River (Tunceli) in Turkey. The dam has a volume of 308 million hm3 on an area of 13.43 m2 that was built in 1996-2003 to obtain the energy needs of the local people. In recent years, water quality monitoring studies of dam lakes has gradually increased. Several studies have reported that determining of water quality parameters and species composition of Uzuncayır Dam Lake (Boztuğ et al., 2012; Saler and Haykır, 2011).

However, no studies have been investigated the studies relative to the water quality of the dam lake to leading by multivariate statistical techniques. In addition to, the study has the distinction of being the first one on Uzuncayır Dam Lake.

This study was done to obtain the results about the similarities and dissimilarities existing among the various water quality parameters of Uzuncayır Dam Lake by using PCA and CA analyses and to ascertain the influence of the pollution sources on the water quality parameters.

Materials and Methods

Locations;In this study, we aimed to determine the distributions of surface and vertical of Uzuncayır Dam Lake that located on the Munzur River in Tunceli, Turkey. The study was conducted with ten stations selected from many different fields as discharge points and purification facility water (study area coordinates 39°04' N: 39°54' E) (Fig. 1).

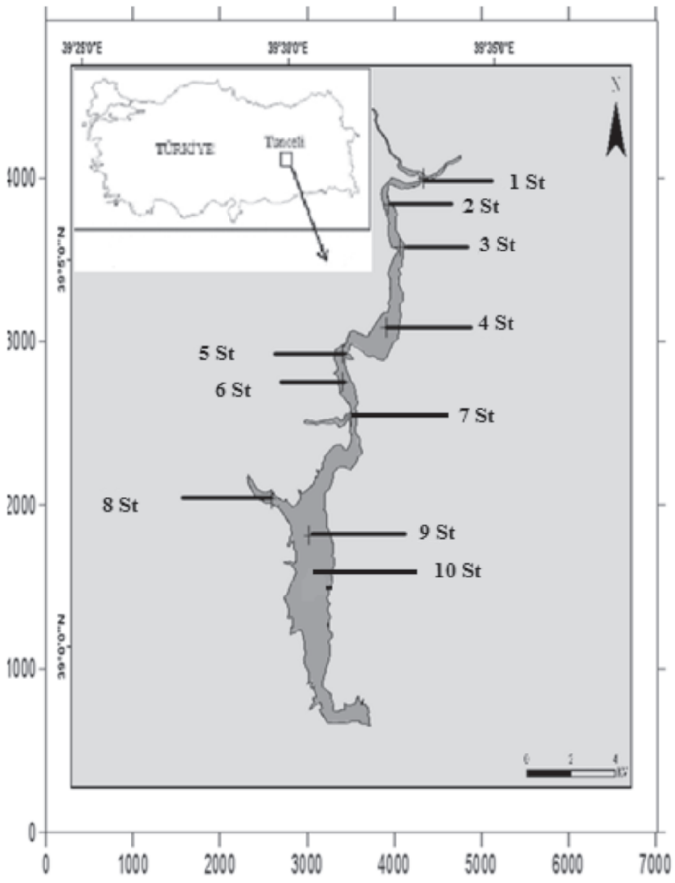

Figure 1. Location of sampling sites in the Uzuncayir Dam Lake. Sites: a site (1 St) from the intersect points of Munzur and Pulumur Rivers; five sites (2, 3, 4, 5 and 6 Sts) from discharge points associated with the city; one site (7 St) from near point of wastewater treatment plant; three sites (8, 9 and 10 Sts) from the beginning, middle and end parts of Uzuncayir Dam Lake.

Table 1. The measured parameters (abbreviations, units and analytical methods)

Variables	Abbrev.	Units	Methodology
Water temperature	*T*	℃	YSI Professional Plus Multiparameter
pH	pH	pH unit	YSI Professional Plus Multiparameter
Sechii Disk		m	Sechii disk
Electrical conductivity	EC	mS/m	Electrometric
Calcium hardness	Ca	mg/L	Flame photometer
Magnesium	Mg	mg/L	Flame photometer
Total hardness	T-Hard	mg/L	Titrimetric
Total alkalinity	T-Alk	mg/L	Titrimetric
Dissolved oxygen	DO	mg/L	Probe method
Biochemical oxygen demand	BOD	mg/L	Dilution and seeding
Ammoniacal nitrogen	NH_4-N	mg/L	Spectrophotometric
Nitrite nitrogen	NO_2-N	mg/L	Spectrophotometric
Total phosphorus	TP	mg/L	Spectrophotometric
Specific Conductance	SC	µS/cm	Probe method
Electrical conductivity	EC	µS/cm	Probe method
Chlorophyll a	Chl-a	µg/L	Spectrophotometric
Salinity	Salinity	%	YSI Professional Plus Multiparameter

Water Quality Parameters; To determine monthly differences in physical, chemical, and biological parameters of water quality of Uzuncayır Dam Lake, the temperature, pH, electrical conductivity (EC), salinity and dissolved oxygen (DO) values were measured in situ by field instruments including a mercury thermometer, digital pH, EC and DO meter, respectively. Water samples were taken from the stations determined in each field study and kept in 1L polyethylene plastic bottles, and filtered through polycarbonate filter (0.45 mm pore size). All water samples were analyzed for within 24 h of collection. The parameters measured in this study specified by abbreviations, units and methodology (Table 1).

Temperature and pH parameters were instantly measured by using YSI Professional Plus Multiple Probe. The light transmittance was measured by helping Secchi disk during sampling time. Nitrite nitrogen (NO_2^-), nitrate nitrogen (NO_3^-), ammonia nitrogen (NH_3-N), phosphorus (P), dissolved oxygen (DO) (mg/L) TS4956 were analyzed as volumetric by using portable Multi-Parameter (YSI Professional Plus). Alkalinity (mg/L) and total hardness (mg/L) was done by measuring the volumetric to use TS 4182 standard (Hackhtest Kit digital

titrator cat no: 16900-01 lot a1004a, wisestir msh_20a) for alkalinity, TS2879 standard for total hardness (Naroteks 100247, Naroteks DGLUWYFK). Conductivity (S/cm) was made with conduct meters by using TS 9748 standard (YSI Professional plus Portable Multi-parameter). Chlorophyll a was determined according to standard method with the help of a spectrophotometer (Carry 60 UVD Model). Determination of chlorophyll-content was read in spectrophotometer (Carry 60 UVD Brand) via standard methods in laboratory (Strickland and Parsons, 1972) (Table 1).

Multivariate statistical analyses; All of the mathematical and statistical computations were made by using Stafgraf Programme. It was aimed to summarize the statistical correlation among water quality parameters of the Dam Lake using PCA (Johnson and Wichern, 1992) and to detect spatial similarity for grouping sampling sites located within the monitoring network using CA (Kaufman and Rousseeuw, 1990; Jarvie et al., 1998).

The concentrations of physico-chemical parameters tend to differ greatly; as such, the statistical results should be highly biased by any parameter having a high concentration. Thus, each water quality parameter was standardized (z-scale) before PCA the analysis was performed in order to minimize the influence of different variables and their respective units of measurements. The calculations were perfor-med based on the correlation matrix of chemical components, and the PCA scores were obtained from the standardized analytical data (Wang et. al., 2006).

Results

The water quality parameters of Uzun-cayır Dam Lake, which gives the range, mean and the standard deviation of the results for each station, are showed in Table 1. Temperature was annually showed a charac-teristics cycle (the highest value 27.03 ^{o}C- the lowest value 4 ^{o}C). pH changes for Uzuncayır Dam Lake varied between 4.7 and 9.88. The mean pH values of the water ranged from very slightly acidic value of 6.23 to slightly basic value of 7.52. The lower values recorded during the wet season as against the dry season might be due to deposition of some organic matter into water from run-off. In same way, minimum and maximum values for total alkalinity and total hardness, mainly a reflection of major ions e.g., Ca^{2+}, Mg^{2+} was determined in these mentioned water sources. Ca^{2+} and Mg^{2+} values varied between 40.1 and 72.1 mg/L and between 8.05 and 49.8 mg/L, respectively. TDS and EC values did not vary significantly in monthly measu-rement of the dam lake during year and varied between 62.67 to 96.00 mg/L $CaCO_3$. While phosphate (PO_4^{3-}) values were range from 0.0 to 1.05 mg/L, ammonia (NH_4^+) were in a relatively narrow range (0.0 and 0.24 mg/L), which is formerly an oligotrophic lake (Table 2).

The result of the PCA base on the correlation matrix of chemical components is expressed in Table 3, and station wise shown in Figure 2.

Six components of PCA analysis showed 68.2% of the variance in the data set, as the eigenvectors classified the 16 physicochemical parameters in the six groups. The first component (PC1) included Mg^{2+}, NH_4^+, NO_2^- which accounted for over 17.7 % similar patterns seen in lake water samples. This group of nutrient parameters also reflected eutrop-hication and organic pollution of lake, suggesting that the anthropogenic pollution mainly stems from discharge of domestic agricultural sewage. The second component (PC2) included NH_4^+, NO_2^- components are arranged according to size. This component

Table 2. The means of different water quality parameters in Uzuncayir Dam Lake

Parameters		Site 1	Site 2	Site 3	Site 4	Site 5
Temp (°C)	R	5,2-21,53	5,2-27,2	5,07-27,03	4,66-26,25	5,2-27,1
	M±Sd.	15,99±8,16	15,24±8,43	14,89±8,11	14,63±7,85	14,91±7,84
pH	R	6,32-9,22	6,58-9,53	6,38-9,66	6,19-9,61	6,53-9,64
	M±Sd.	8,13±0,79	8,32±0,73	8,04±0,87	8,08±0,94	8,18±0,81
EC (µS/cm)	R	113±395	114±395	117±413	121±411	128±328
	M±Sd.	211-572	232-574	216-588	212-584	58-509
DO (mg/L)	R	4,5-13,92	4,34-15,13	5,19-15,11	6,31-14,65	5,23-15,48
	M±Sd.	9,98±1,89	10,26±2,25	10,27±2,12	10,23±1,96	9,78±1,89
TDS (mg/L)	R	0,1-0,51	0,17-0,51	0,18-0,51	0,07-0,51	0,21-0,5
	M±Sd.	0,33±0,13	0,34±0,13	0,35±0,12	0,35±0,12	0,3±0,14
Ca^{2+} (mg/L)	R	10,8-153	20,04-161	17,23-142	12,02-169	18,04-148
	M±Sd.	48,40±35,11	48,83±35,98	41,49±32,07	49,25±34,21	43,97±34,21
Mg^{2+} (mg/L)	R	20,52-39,7	8,05-37,5	26,2-38,7	18,9-38,1	25,1-35,1
	M±Sd.	32,27±5,41	32,15±7,97	34,32±4,60	30,15±5,78	31,29±3,72
T-hard (mg/L)	R	146-200	149-200	125-200	132-200	129-189
	M±Sd.	168,41±21,45	174,41±16,78	167,66±23,46	170,66±23,46	157,16±14,97
Secchi Disk (m)	R	6,35-11,9	5,68-10,82	4,46-10,68	4,32-10,28	2,86-8,38
	M±Sd.	8,87±1,85	7,75±1,89	7,31±2,59	6,44±2,20	5,86±2,03
Specific	R	202-729	223-797	215-791	210-790	216-781
Conductance	M±Sd.	450,6±221,34	451,7±222	463,75±226,55	469,15±226,55	405±217
(µS/cm)						
NH_4-N (mg/L)	R	0-0,1	0-0,09	0-0,15	0-0,13	0-0,24
	M±Sd.	0,03±0,034	0,024±0,03	0,030±0,042	0,03±0,044	0,04±0,06
NO_3-N (mg/L)	R	0-1,09	0-12	0,2-10,80	0-14,1	0-11,4
	M±Sd.	0,67±0,24	4,78±3,48	2,32±2,41	3,09±3,03	3,27±3,02
NO_2-N (mg/L)	R	0-0,35	0-0,044	0-0,033	0-0,051	0-0,19
	M±Sd.	0,11±0,010	0,011±0,012	0,010±0,009	0,012±0,015	0,020±0,038
PO_4^{3-} (mg/L)	R	0,04-1,12	0,08-0,56	0,00-0,82	0,01-0,65	0-1
	M±Sd	0,38±0,33	0,27±0,13	0,29±0,23	0,27±0,19	0,36±0,26
BOI (mg/L)	R	1,54-12,39	0,93-12,1	3,34-6,34	3,74-6,56	3,31-6,86
	M±Sd.	4,71±2,78	4,67±2,99	5,54±0,81	5,69±0,93	5,17±1
Chl-a (mg/L)	R	0-1,78	0-1,68	0-1,82	0-1,86	0-1,79
	M±Sd.	0,36±0,58	0,32±0,55	0,38±0,54	0,36±0,58	0,14±0,40

Continue of Table 2.

Parameters		Site 6	Site 7	Site 8	Site 9	Site 10
Temp (°C)	R	4-26,7	4,9-25,8	4,2-22,39	5,99-25,97	6,23-17,32
	M±Sd.	14,47±7,84	15,08±8,4	12,02±5,89	13,81±7,52	9,16±3,13
pH	R	6,48-9,57	6,36-9,41	4,7-9,7	6,31-9,79	7-9,88
	M±Sd.	8,26 ±0,79	8,11±0,76	8,36±0,76	8,16±0,94	8,16±0,74
EC (µS/cm)	R	211--581	212-588	212-552	214-550	216-439
	M±Sd.	381,60±128,84	387±125,54	417,41±136,52	388,16±108,52	327,41±82,60
DO (mg/L)	R	7,07-12,22	7,02-11,88	7,28-15,42	7,14-15,48	6,4-12,74
	M±Sd.	9,61±1,49	9,78±1,38	10,31±2,18	9,97±2,28	9,92±1,92
TDS (mg/L)	R	0,21-0,5	0,21-0,5	0,01-0,5	0,2-0,51	0,18-0,42
	M±Sd.	0,38±0,1	0,34±0,11	0,33±0,14	0,35±0,12	0,33±0,08
Ca^{2+} (mg/L)	R	9,62-152	7,2-133	132,2-195,3	11,6-187	6,01-180
	M±Sd.	38,75±37,53	38,11±31,33	50,94±47,09	46,85±45,79	47,70±43,29
Mg^{2+} (mg/L)	R	26,2-38,8	20,1-37,8	27,1-49,8	21,6-39,8	20,7-40,1
	M±Sd.	32,03±4,21	31,13±6,50	31,32±6,14	31,69±6,13	34,3±6,99
T-hard (mg/L)	R	121-200	90-198	120-200	127-218	96-200
	M±Sd.	156,83±24,79	155,5±30,35	164,25±30,68	178,58±27,28	163,33±33,03
Secchi Disk (m)	R	4,05-8,65	3,24-8,92	1,35-4,73	2,97-6,22	6,35-11,09
	M±Sd.	6,26±1,60	5,99±2,51	3,43±1,16	4,53±1,13	4,70±1,15
Specific	R	211-780	216-781,4	213-816	210-782	210-619
Conductance	M±Sd.	454,84±222,98	450,98±226,87	471,7±215,87	445,52±229,43	384,1±166,58
(µS/cm)						
NH_4-N (mg/L)	R	0-0,21	0-0,22	0-0,4	0-0,5	0-0,8
	M±Sd.	0,053±0,066	0,052±0,071	0,068±0,096	0,064±0,10	0,097±0,20
NO_3-N (mg/L)	R	0-9,9	0,21-1,59	0-8,6	0-1,07	0-1,2
	M±Sd.	3,38±2,80	0,67±0,32	3,38±2,17	0,55±0,28	0,63±0,34
NO_2-N (mg/L)	R	0-0,07	0-0,08	0-0,09	0-0,08	0-0,06
	M±Sd.	0,00±0,021	0,014±0,021	0,010±0,018	0,011±0,016	0,010±0,013
PO_4^{3-} (mg/L)	R	0,028-0,85	0,04-1,02	0-0,88	0,01-1,05	0,02-0,77
	M±Sd.	0,28±0,21	0,32±0,27	0,30±0,24	0,39±0,28	0,26±0,21
BOI (mg/L)	R	3,56-6,83	3,26-6,4	3,21-10,47	4,4-9,3	3,9-9,1
	M±Sd.	5,28±0,91	5,02±0,94	6,79±2,45	6,77±1,72	5,9±1,91
Chl-a (mg/L)	R	0-1,86	0-1,93	0-1,06	0-1,27	0-1,24
	M±Sd.	0, 23±0,43	0,07±0,24	0,17±0,40	0,20±0,42	0,12±0,34

R: Range; M: Mean; Sd: Standard deviation

Table 3. Eigenvector and eigenvalues on the correlation matrixes of concentration of physico-chemical parameters in Uzunçayır Dam Lake

Parameters	PC1	PC2	PC3	PC4	PC5	PC6
BOI (mg/L)	-0,0123544	-0,0492925	-0,177565	0,645819	-0,289357	-0,0734819
Ca^{2+} (mg/L)	-0,515513	0,213865	0,0696896	0,00299402	-0,00241548	0,0215258
Chl-a (mg/L)	-0,0766323	-0,0622579	-0,109927	-0,262384	0,0842049	-0,401617
Conductance (uS/cm)	-0,168471	-0,513518	0,0516292	0,0191191	0,0581904	0,0671107
Dissolved Oxygen (mg/L)	-0,0807015	-0,047231	0,185879	0,551969	0,189064	0,21991
Mg^{2+} (mg/L)	0,00793401	-0,0443709	-0,038054	0,0404395	0,501024	-0,624871
NH_4^+ (mg/L)	0,106655	0,346186	0,350553	-0,00573114	-0,27844	-0,307643
NO_2^- (mg/L)	0,0602708	0,236804	0,246331	0,222407	0,0702621	-0,247295
NO_3^- (mg/L)	-0,119942	-0,0785318	-0,334853	-0,0984379	-0,476053	-0,0844857
pH	-0,121894	-0,239264	0,0234485	0,191499	-0,431602	-0,463184
PO_4^{3-} (mg/L)	-0,114766	-0,0305554	0,371817	0,138431	0,0999155	-0,0456888
Secchi Depth (m)	-0,537841	0,166953	-0,0268449	-0,0702932	0,0296559	0,0017916
Specific Conductance (uS/cm)	-0,162608	-0,410576	0,0137677	0,119799	0,224509	-0,0501474
TDS	-0,102264	-0,454556	0,293997	-0,219381	-0,145983	-0,0158003
Temperature (°C)	-0,0820888	0,08318	-0,622812	0,152214	0,202522	-0,071143
T-Hard (mg/L)	-0,55039	0,17263	0,0559953	-0,0421944	-0,00743592	0,0460461
Eigenvalue	1,07	0,97	0,85	0,81	0,70	0,56
Variability %	6,71	6,09	5,36	5,12	4,407	3,51
Cumulative %	68,29	74,34	79,72	84,83	89,24	92,72

accounted 34.95 % of the total variance measured that demonstrated strong positive loading for major ions. The PC3, PC4, PC5, PC6 components include the physical parameters, which demonstrated 45.6 % 53.8 %, 61.5 %, 68.2% of total variance respectively.

Discussion

This study involves determination of physical, biological and chemical parameters of surface water at different points. Water temperature is one of the most important physical characteristics because of controlling the solubility of gases in water, and the reactionrate of chemicals, the toxicity of ammonia, and of chemotherapeutics to aqueous animals like fish (IEPA, 2001). The value of water temperature of our study was ranged from 4-27.03 °C and showed a characteristic annual cycle for Uzuncayır Dam

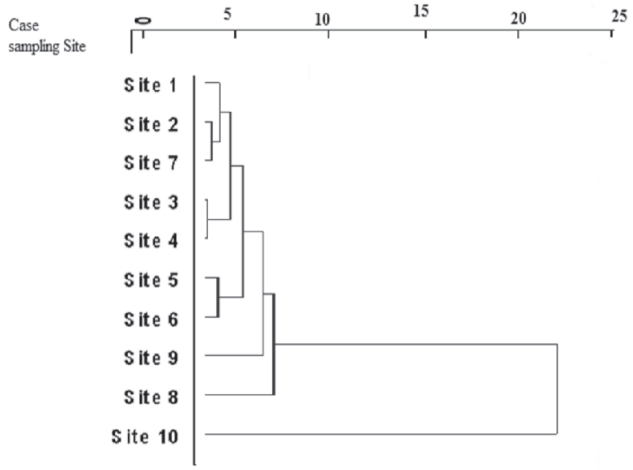

Figure 2. Dendogram of sampling sites obtained by Ward's method as a result of CA.

Lake. Our data showing characteristic values annually is close the value proposed by Zhao et al (2012). The pH is of major importance in determining of water quality. The acidic pH is a characteristic of oligotrophic water bodies whereas, the neutral and alkaline pH are shown by eutrophic and mesotrophic nature of water bodies, respec-tively (Jitendra, et al., 2008; Soni, et al., 2013). The pH findings have slightly alkaline ranged between 4.7 and 9.8. In a study done by Dirican (2015) high pH mean values (8.03±0.04 and 8.30±0.00) was determined in surface water of Çamlıgöze Dam Lake. The concentrations of DO concentration affected by weather and changes in inflowing streams (e.g., higher, more turbulent flow during winter months) were between 4.34 and 15.48 in the study.

Phosphorus is one of the essential nutrients necessary for the nutrition and growth of living organisms. Typical PO_4^{3-} concentrations in surface waters of Dam Lake ranged from 0.001 mg/L in unpolluted water to 0.30 mg/L or more in nutrient enriched waters. Excessive amounts of phosphates in water column can lead to eutrophication, a condition of accelerated, algal production to extreme quantities until they die off (South African Water Quality Guidelines, 1996). The highest level of phosphate in the dam lake has been calculated to be 0.14 mg/L, and this result indicates that there is no threat in terms of aquaculture and aquatic life (Mutlu et al., 2015). In our study, the highest phosphorus level in the surface water was from the middle parts of Uzuncayir Dam Lake (site 9) which located close to the domestic waste. Inorganic nitrogen found in water in the form of nitrate (NO_3^-), nitrite (NO_2^-) and ammonium (NH_4^+) known to be nitrogen forms play an important role in nitrogen cycle in nature.

High nitrate concentration is an indicator of eutrophication of the lake. It means the excessive growth of aquatic plants and algae in lake. Amounts of NO_3^-, NO_2^- and NH_4^+ in the study were range of 1.59, 0.19 and 0.24 respectively that they were normal levels (EIE, 1996). In PCA analysis included six components, 16 physicochemical parameters were classified and showed 68.2% of the variance in

the data set. Component 1, 2, 3, 4, 5 and 6 explained 17.7, 34.95, 45.6, 53.8, 61.5 and 68.2 % of the variance respectively. Component 1 gives information about the variations in Mg^{2+}, NH_4^+ and NO_2^- (Liu, et al., 2003). This component represents anthropogenic pollution from domestic agricultural sewage as well as the geological composition of the area. Component 2 show that NH_4^+, NO_2^- components are arranged according to size because of strong positive loading for major ions. Uzuncayir Dam Lake was characterized by high values for Mg^{2+}, NH_4^+ and NO_2^- parameters, which can be associated with the length and geological structure of Uzuncayir Dam Lake (Solaraj et. al., 2010). It is thought that high nitrite and ammonium concentrations are in line with low flow rate and low oxygen content with respect to urban wastewater and agricultural activities. Uzuncayir Dam Lake was characterized by higher chlorophyll-a concentration compared to other stream.

Cluster analysis grouped 10 sampling sites into five clusters according to similar water quality characteristics. As a result of the cluster analysis, 2.7 and 1 sampling stations showed the same characteristics. For example, move through areas 3 and 4, 5 and 6 samples showed zones of similar characteristics. 8, 9 and 10 Sts, for example, move on the areas of strean water and wastewater and agriculture activities. In addition, it was observed that 10 St was affected by the pollution (Ayeni and Soneye, 2013).

Kaynaklar

Adams, S., Titus, R., Pietesen, K., Tredoux, G. and Harris, C. 2001. Hydrochemical characteristic of aquifers near Sutherland in the Western Karoo. South Africa. Journal of Hydrology, 241: 91-103. doi:10.1016/S0022-1694(00)00370-X

Andrade, E. M., Palácio, H. A. Q., Souza, I. H., Leão, R. A. and Guerreiro, M. J. 2008. Land use Effects in Groundwater Composition of an Alluvial Aquifer (Trussu River, Brazil) by Multivariate Techniques. Environmental Research, 106: 170-177. doi: 10.1016/j.envres.2007.10.008.

Ayeni, A. O. and Soneye, A. S. O. 2013. Interpretation of surface water quality using principal components analysis and cluster analysis. Journal of Geography and Regional Planning, 6(4): 132-141. doi: 10.5897/JGRP12.087.

Bathusha, M. I. and Saseetharan, M. K. 2006. Statistical study on physico chemical characteristics of ground water of coimbatore south zone. Indian Journal environmental Protection, 26(6): 508 - 515.
doi: http://dx.doi.org/10.12944/CWE.10.2.26

Boztuğ, D., Dere, T., Tayhan, N., Yıldırım, N., Danabaş, D., Cikcikoğlu, Y. N., Öztüfekçi, Ö. A., Danabaş, S., Ergin, C., Uslu, G. and Ünlü, G. 2012. Physico-chemical characteristics of Uzuncayir Dam Lake (Tunceli) and water quality. Adıyaman University, Journal of Science and Technology 2 (2): 93-106.

Dirican, S. 2015. Assessment of water quality using physico-chemical parameters of Çamlıgöze Dam Lake in Sivas, Turkey. Ecologia, 5 (1): 1-7.
doi: 10.3923/ecologia.2015.1.7

Easton, Z. M., Gerard-marchant, P., Walter, M. T., Petkovic A. M. and Steenhuis, T. S. 2007. Identifying dissolved phosphorus source areas and predicting transport from an urban watershed using distributed hydrologic modeling. Water Resources Research, 43: 5-16.
doi:10.1029/2006WR005697

EİE. 1996. 1992 Su Yılı Akım Değerleri. EİE Genel Müdürlüğü Yayınları, Ankara, 9525. Helena, B., Pardo, R., Vega, M., Barrado, E., Ferna´ndez, J. M. and Ferna´ndez, L. 2000. Temporal evolution of groundwater composition in an alluvial aquifer (Pisuerga River, Spain) by principal component analysis. Water Research, 34: 807-816. Doi:10.1016/S0043-1354(99)00225-0.

IEPA (Ireland Environmental Protection Agency), 2001. Parameters of Water Quality Interpretation and Standards. Environ- mental Protection Agency, Johnstown, p: 133.

Jarvie, H. P., Whitton, B. A. and Neal, C. 1998. Nitrogen and phosphorus in east coast British rivers: Speciation, sources and biological significance. Sci Total Environ, 211: 79109.
doi:10.1016/S0048-9697(98)00109-0

Jitendra, K., Siddharth, S. and Amit, P. 2008. Water quality of Turamdih and Jaduguda uranium mines and adjacent areas, East Singhbhum, Jharkhand. J. Ecophysiol. Occup. Health, 8: 7-14.

Johnson, R.A. and Wichern, D.W. 1992. Applied multivariate statistical analysis, 3. Edn. Prentice Hall, Englewood Cliffs, NJ.

Kaufman, L. and Rousseeuw, P. J. 1990. Finding groups in data: an introduction to cluster analysis. New York, Wiley.

Lee, J. Y., Cheon, J. Y., Lee, K. K., Lee, S. Y. and Lee, M. H. 2001. Statistical evaluation of geochemical parameter distribution in a ground water system contaminated with petroleum hydrocarbons. Journal of Environmental Quality, 30: 1548-1563. doi: 10.2134/jeq2001.3051548x

Liu, C. W., Lin, K. H. and Kuo, Y. M. 2003. Application of factor analysis in the assessment of groundwater quality in a Blackfoot disease area in Taiwan. Science. Total Environmental, 313: 77-89. Doi:10.1016/S0048-9697(02)00683-6

Niemi, G. J., Devore, P., Detenbeck, N., Taylor, D. and Lima, A. 1990. Overview of Case Studies on Recovery of Aquatic Systems from Disturbance. Environmental Management, 14: 571-587.

Mutlu, E., Kutlu, B. and Demir, T. 2016. Assessment of Çinarli Stream (Hafik -Sivas)'S Water Quality via Physico-Chemical Methods. Turkish Journal of Agriculture - Food Science and Technology, 4(4): 267-278.

Mutlu, E., Yanik, T., Akca, İ., Kutlu, B. and Sönmez, A. S. 2015. Determining the water quality of Lake Delice (İmranli-Sivas). Marine Science Technology Bulletin, 4(2):11-19.

Reghunath, R., Murthy, T. R. S. and Raghavan, B. R. 2002. The utility of multivariate statistical techniques in hydrogeochemical studies: an example from Karnataka, India. Water Research, 36: 24372442. doi:10.1016/S0043-1354(01)00490-0

Saler, S. and Haykır, H. 2011. Zooplankton composition of Pulumur Stream (Tunceli-Turkey). Journal of Animal and Veterinary Advances, 10(11): 1401-1413. doi: 10.3923/javaa.2011.1401.1403

Sickman, J. O., Zanoli, M. J. and Mann, H. L. 2007. Effects of urbanization on organic carbon loads in the Sacramento River, California. Water Resources Research, 43: 1-15. doi: 10.1029/2007WR005954

Simeonov, V., Simeonova, P. and Tsitouridou, R. 2004. Chemometric quality assessment of surface waters: two case studies. Chemical Engineer. Ecology, 11: 449469.

Simeonova, P., Simeonov, V. and Andreev, G. 2003. Water quality study of the Struma River Basin, Bulgaria (19891998). Central European Journal of Chemistry, 1: 136212.

Singh, K. P., Malik, A., Mohan, D. and Sinha, S. 2004. Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India)-a case study. Water Research, 38(18): 3980-3992. doi:10.1016/j.watres.2004.06.011

Singh, K. P., Malik, A. and Sinha, S. 2005. Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniques: a case study. Analytica Chimica Acta, 538: 355-374. doi:10.1016/j.aca.2005.02.006

Sinha, M. R., Dev, A., Prasad, A., Ghosh, M. and Tagore, R. N. 2011. Physicochemical examination and quality assessment of groundwater (Hand-Pump) around Patna main town, Bihar state, India. Journal of Chemical and Pharmaceutical Research, 3(3): 701-705.

Solaraj, G., Dhanakumar, S., Murthy, K. R. and Mohanraj, R. 2010. Water quality in select regions of Cauvery Delta River basin, southern India, with emphasis on monsoonal variation. Environmental Monitoring and Assessment, 166: 435-44. doi: 10.1007/s10661-009-1013-7

Soni, V. K., Visavadia, M., Gosai, C., Hussain, M. D., Mewada, M. S., Gor, S. and Salahuddin, K. 2013. Evaluation of physico-chemical and microbial parameters on water quality of Narmada River, India. Afr. J. Environ. Sci. Technol., 7: 496-503.

South African Water Quality Guidelines, 1996. Agricultural Use: Livestock Watering. Department of Water Affairs and Forestry, Pretoria, 2nd ed., Vol. 4.

Strickland, J. D. H. and Parsons, T. R. 1972. A practical handbook of seawater analysis, fisheries research boards of Canada. Bull, 167. Ottawa, pp: 310.

Treseder, K. K. 2008. Nitrogen Additions and Microbial Biomass: A Meta-analysis of Ecosystem Studies. Ecological Letter, 11: 1111-1120. doi: 10.1111/j.1461-0248.2008.01230.x

Vega, M., Pardo, R., Barrado, E. and Deban, L. 1998. Assessment of seasonal and polluting effects on the qualityof river water by exploratory data analysis.Water Research, 32: 35813592.

Wang, Y. S., Lou, Z. P., Sun, C. C., Wu, M. L. and Han, S. H. 2006. Multivariate statistical analysis of water quality and phytoplankton characteristics in Daya Bay, China, from 1999 to 2002. Oceanologia, 48: 193-213.

Wu, M. L. and Wang, Y. S. 2007. Using chemometrics to evaluate anthropogenic effects in Daya Bay, China. Estuarine, Coastal and Shelf Science, 72: 732742. doi:10.1016/j.ecss.2006.11.032

Wunderlin, D. A., Diaz, M. P., Ame, M. V., Pesce, S. F., Hued, A. C. and Bistoni, M. A. 2001. Pattern recognition techniques for the evaluation of spatial and temporal variations in water quality. A case study: Suquia river basin (Cordoba, Argentina). Water Research, 35: 28812894.

Zhao, O., Liu, S., Li, D., Z. Yang, Shikui, D., Cong, W. and Zhaoling, Z. 2012. Spatio-temporal variation of heavy metals in fresh water after dam construction: a case study of the Manwan Reservoir, Lancang River. Environmental Monitoring Assessment, 184: 42534266. doi: 10.1007/s10661-011-2260-y