QUALITY ASSESSMENT OF SUPPLY WATER OF GJAKOVA CITY (KOSOVO): A CASE STUDY OF CORRELATION COEFFICIENTS BETWEEN CHEMICAL DATA

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Abstract. In this study the quality assessment of supply water of Gjakova in the period time January to October was investigated. Statistical studies have been carried out by calculating of basic statistical parameters, anomalies and correlation coefficients between different pairs of variables. From the results of field work and laboratory analyses it was found out that supply water of Gjakova fulfill the criteria set by the World Health Organization and the low distribution of physico-chemical parameters indicated lithological pollutions. The statistical regression analysis has been found a moderately high positive correlation relationship between pH and EC, consumption of $KMnO_4$, Turbidity, Cl^-, Al^{3+} and NO_3^-. Result dates suggest also strong positive correlations of EC with Turbidity, consumption of $KMnO_4$, Cl^-, Al^{3+} and NO_3^-. R-mode cluster analysis showed mutual links between studied parameters. It could be observed on water samples that EC has closest linkages with consumption of $KMnO_4$ and they form first branch of the dendogram. Also EC has closest linkages with NO_3^- and they form second branch of the dendogram.

Keywords: quality assessment; supply water; statistical analysis; correlation coefficients; Gjakova

Introduction

In 2010, about 85% of the global population (6.74 billion people) had access to piped water supply through house connections or to an improved water source through other means than house, including standpipes, water kiosks, spring supplies and protected wells. However, about 14% (884 million people) did not have access to an improved water source and had to use unprotected wells or springs, canals, lakes or rivers for their water needs. A clean water supply - in particular water that is not polluted with fecal matter from lack of sanitation - is the single most important determinant of public health.Destruction of water supply and/or sanitation infrastructure after major catastrophes (earthquakes, floods, war, etc.)

poses the immediate threat of severe epidemics of waterborne diseases, several of which can be life-threatening (Water supply). Virtually all large systems must treat the water; a fact that is tightly regulated by global, state and federal agencies, such as the World Health Organization (WHO) or the United States Environmental Protection Agency (EPA). Water treatment must occur before the product reaches the consumer and afterwards (when it is discharged again). Water purification usually occurs close to the final delivery points to reduce pumping costs and the chances of the water becoming contaminated after treatment (water supply network). Water supply systems get water from a variety of locations after appropriate treatment, including groundwater (aquifers), surface water (lakes and rivers), and the sea through desalination. The water treatment steps include, in most cases, purification, disinfection through chlorination and sometimes fluoridation. Treated water then either flows by gravity or is pumped to reservoirs, which can be elevated such as water towers or on the ground (for indicators related to the efficiency of drinking water distribution see non-revenue water). Once water is used, wastewater is typically discharged in a sewer system and treated in a sewage treatment plant before being discharged into a river, lake or the sea or reused for landscaping, irrigation or industrial use. The sources of physicochemical contamination are numerous and include the land disposal of sewage effluents, sludge and solid waste, septic tank effluent, urban runoff and agricultural, mining and industrial practices (Close et al., 2008; Keswick, 1984). The quality of drinking water is an issue of primary interest for the residents of the European Union (Chirila at al., 2010). In peat bogs, water flows freely in the active layer of water or acrotelm. Water storage is critical to the balance of water in peat swamps and at surrounding areas. Logging activity, agriculture, peat extraction and destruction of peat swamp drainage activity also give a negative effect and has a bad implication on the hydrology (Hamilton, 2008). Therefore, multidisciplinary collaborative research is essential for understanding the pollution processes. As reported by Brils (2008), adequate water quality in Europe is one of the most eminent concerns for the future. Good management of natural and environmental waters will give results if leading institutions constantly monitor information about environmental situation. Therefore, seeing it as a challenge for environmental chemists, our goal is to determine the amount and nature of pollutants in the environment.

Until recently, the waters of Kosovo have been poorly investigated. Gashi et al. (2009) performed first step with investigation of the rivers Drini i Bardhë, Morava e Binçës, Lepenc and Sitnica, which are of supra-regional interest. They performed investigations of mineralogical and geochemical composition and of contamination status of stream sediments of mentioned rivers of Kosovo. By comparing the concentrations of toxic elements with the existing criteria for sediment quality, in that study was found that two sites in Sitnica River are significantly polluted, especially locations in Fushë Kosova and in Mitrovica. As Drenica River is the most important tributary of Sitnica river, the current paper presents next step in detailed investigation and monitoring of Sitnica river watershed, which is most polluted river system in Kosovo. Gashi et al. (2011; 2013; 2014; 2016a; 2016b) performed research of concentrations of ecotoxic elements in waters of main rivers and in water samples from Badovci Lake of Kosovo. The main goal of that work was to suggest to authorities concerned a monitoring network on main rivers of Kosovo (Drini i Bardhë, Morava e Binçës, Lepenc and Sitnica). The authors also aimed to suggest application of WFD (Water Framework Directive) in Kosovo as soon as possible and performed research could be the first step towardsit, giving an opportunity to plan the monitoring network in which pollution locations will be highlighted. The authors highlighted two locations in Sitnica River as very polluted with ecotoxic elements and possible remediation by Kosovo authorities concerned was suggested. The aim of the current work is to perform quality assessment of supply waters of Gjakova city (Fig. 1).

Study area

Gjakova city is located in south-weastern part of Kosova, at the geographical coordinates 42°23′ N and 20°26′ E. Gjakova is a city and municipality, and covers an area of 521 km^2, including the town of Gjakova and 84 villages. Gjakova is situated at the Southern end of the Dinaric Alps and is approximatly 100 km inland from the Adriatic Sea (Gjakova). Five sample stations were selected and for our investigation 12 parameters were determined. The results are interpreted using modern statistical methods that can be used to locate pollution sources. The levels of some physicochemical parameters of waters are compared with the World Health Organization statndards for drinking water.[1,2)]

Sampling and sample preparation/characterization

For chemical analysis water samples are collected during the period from January to October, 2016. Samples of supply water, previously were rinsed three times with sampled water, and labeled with the date and the name of the sample station. These samples are transferred to refrigerator (at 4° C) for analysis in the laboratories. All tests are performed at least thrice to calculate the average value. Sampling, preservation and experimental procedure for the water samples are carried out according to the standard methods for examination of water (Baba et al., 2003; Dalmacija, 2000). Samples are preserved in refrigerator after treatment.

Double distilled water was used in all experiments. All instruments are calibrated according to manufacturer’s recommendations. pH measurements were performed using pH/ion-meter of Hanna Instruments. Electrical conductivity was measured by „InoLab WTW“ conductometer. Depending on chemical reactions with volumetric (argentometry and oxidoreduction) methods were defined concentration of chlorides and chemical consumption of $KMnO_4$ (Thiemann Küebel vol-

Fig. 1. Area map with analysis location.

umetric method, boiling in acidic environment). Residual chlorine was determined using „DPD1"colorimetry technique. Turbidity was measured by "HANNA, HI 93703 MICROPROCESOR". Concentrations of Fe^{2+}, Al^{3+}, Mn^{2+}, NO_2^-, NO_3^- and NH_4^+ were determined using UV-VIS spectrometry method, using "Merck Spectroquant NOVA 60 Fotomoter".

Statistical methods

Program Statistica 6 (Statsoft[3]) was used for the statistical calculations in this work, such as: descriptive statistics, Pearson's correlation factor and two dimensional box plot diagrams for determination of anomalies (extremes and outliers) for solution data. Relationships between the observed variables were tested by means of correlation analysis. The level of significance was set at $p < 0.05$ for all statistical analyses. It was qualitatively assumed that the absolute values of r between 0.3 and 0.7 indicate good association, and those between 0.7 and 1.0 strong association between elements.

Results and discussion

The physicochemical parameters of supply water after chemical treatment, i.e., pH, EC, turbidity, consumption of $KMnO_4$ and concentrations of NH_4^+, NO_2^-, NO_3^-, Cl^-, residual chlorine, Fe^{2+}, Al^{3+} and Mn^{2+} were presented in Tables 1 and 2. The Descriptive statistics summary of the selected variables at water samples are presented in Table 3. For each variable, the values are given as arithmetic mean, geometric mean, median, minimal and maximal concentration, variance and standard deviation. Box-whiskers plot for 8 measured variables are presented in Fig. 2. Using experimental data (Tables 1 and 2) and box plot approach of Tukey (1977), anomalous values (extremes and outliers) of 12 variables were determinate (Table 4).

Table 1. Some physico-chemical parameters of supply waters in 5 sample stations

Parameter	Sample station	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.
pH	P_1	7.31	7.29	7.30	7.36	7.28	7.37	7.25	7.16	7.14	7.23
	P^2	7.33	7.34	7.27	7.33	7.33	7.24	7.23	7.18	7.15	7.19
	P_3	7.32	7.33	7.32	7.34	7.34	7.26	7.20	7.20	7.18	7.18
	P_4	7.36	7.20	7.36	7.30	7.37	7.33	7.29	7.23	7.20	7.16
	P_5	7.30	7.34	7.31	7.29	7.37	7.31	7.18	7.19	7.21	7.18
EC /μScm^{-1}	P_1	234	235	230	230	231	237	222	223	218	223
	P_2	238	230	231	229	233	236	218	227	216	220
	P_3	231	234	235	233	235	234	216	220	220	217
	P_4	235	238	237	231	237	237	213	221	219	219
	P_5	237	231	230	237	237	229	217	219	221	222
Turbidity /NTU	P_1	0.12	0.08	0.16	0.16	0.08	0.19	0.12	0.11	0.25	0.10
	P_2	0.09	0.05	0.11	0.18	0.10	0.11	0.16	0.14	0.12	0.11
	P_3	0.16	0.10	0.12	0.14	0.12	0.13	0.18	0.09	0.11	0.12
	P_4	0.13	0.18	0.18	0.11	0.18	0.19	0.14	0.08	0.009	0.13
	P_5	0.11	0.12	0.16	0.09	0.18	0.10	0.15	0.07	0.008	0.11
Cons. of $KMnO_4$ /$mgdm^{-3}$	P_1	4.108	4.108	4.424	4.108	4.108	3.16	3.476	3.16	3.16	3.476
	P_2	4.424	4.74	4.74	4.74	4.74	3.476	3.476	3.476	3.16	3.792
	P_3	4.74	4.424	4.108	4.124	4.108	3.792	3.792	3.476	3.476	3.792
	P_4	4.74	4.108	4.424	4.74	4.124	3.792	3.16	3.792	3.792	3.16
	P_5	4.108	4.74	4.74	4.108	4.424	3.16	3.792	3.476	3.16	3.476
Cl, residual /$mgdm^{-3}$	P_1	0.3	0.25	0.25	0.25	0.25	0.3	0.25	0.3	0.3	0.3
	P_2	0.3	0.3	0.25	0.20	0.3	0.25	0.25	0.25	0.3	0.25
	P_3	0.3	0.3	0.30	0.25	0.25	0.20	0.3	0.3	0.3	0.25
	P_4	0.25	0.20	0.30	0.25	0.3	0.25	0.3	0.30	0.25	0.25
	P_5	0.25	0.25	0.3	0.20	0.3	0.25	0.30	0.25	0.25	0.25

Cl- /mgdm^{-3}	P_1	5.63	5.63	5.57	5.66	5.70	5.77	5.60	5.47	5.56	5.51
	P_2	5.70	5.64	5.67	5.72	5.62	5.74	5.63	5.41	5.63	5.49
	P_3	5.52	5.72	5.69	5.71	5.60	5.67	5.67	5.33	5.54	5.44
	P_4	5.66	5.61	5.63	5.73	5.65	5.68	5.69	5.38	5.53	5.48
	P_5	5.59	5.74	5.60	5.69	5.65	5.70	5.71	5.50	5.52	5.50
Fe^{2+} /mgdm^{-3}	P_1	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.02
	P_2	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02
	P_3	0.01	0.02	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.01
	P_4	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02
	P_5	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02
Al^{3+} /mgdm^{-3}	P_1	0.03	0.04	0.04	0.03	0.03	0.04	0.03	0.04	0.03	0.04
	P_2	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.04	0.03	0.03
	P_3	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.04
	P_4	0.03	0.03	0.03	0.05	0.04	0.03	0.03	0.03	0.03	0.04
	P_5	0.04	0.04	0.03	0.03	0.04	0.03	0.04	0.04	0.03	0.03
Mn^{2+} /mgdm^{-3}	P_1	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03
	P_2	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02
	P_3	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02
	P_4	0.03	0.02	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.03
	P_5	0.02	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.04	0.03
NH_{4+} /mgdm^{-3}	P_1	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
	P_2	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.07	0.06	0.06
	P_3	0.07	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.04	0.07
	P_4	0.06	0.05	0.06	0.05	0.05	0.05	0.06	0.07	0.06	0.06
	P_5	0.05	0.06	0.05	0.06	0.05	0.06	0.06	0.06	0.07	0.06
NO_{2-} /mgdm^{-3}	P_1	0.002	0.003	0.002	0.003	0.002	0.003	0.002	0.003	0.002	0.002
	P_2	0.003	0.002	0.003	0.002	0.003	0.002	0.002	0.003	0.003	0.003
	P_3	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.002
	P_4	0.003	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.003
	P_5	0.002	0.003	0.002	0.003	0.002	0.002	0.002	0.002	0.003	0.003
NO_{3-} /mgdm^{-3}	P_1	0.5	0.6	0.5	0.6	0.5	0.6	0.5	0.6	0.5	0.6
	P_2	0.5	0.5	0.5	0.6	0.6	0.6	0.5	0.5	0.5	0.6
	P_3	0.6	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.6	0.5
	P_4	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.5
	P_5	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.5	0.5

Table 2. Average values of physico-chemical parameters of waters in 5 sample stations

	WHO	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
pH	6.5-8.5	7.324	7.3	7.312	7.324	7.338	7.302	7.23	7.192	7.176	7.188
EC /μScm^{-1}	1000	235	233.6	232.6	232	234.6	234.6	217.2	222	218.8	220.2
Turbidity / NTM	1	0.122	0.106	0.146	0.136	0.132	0.144	0.15	0.098	0.0994	0.114
C. of $KMnO_4$ /mgdm^{-3}	10	4.424	4.424	4.4872	4.364	4.3008	3.476	3.5392	3.476	3.3496	3.5392
Cl, resid. / mgdm$_{-3}$	0.3	0.28	0.26	0.28	0.23	0.28	0.25	0.28	0.28	0.28	0.26
Cl- /mgdm^{-3}	250	5.62	5.668	5.632	5.702	5.644	5.712	5.66	5.418	5.556	5.484
Fe^{2+} /mgdm^{-3}	0.3	0.016	0.016	0.012	0.016	0.018	0.014	0.016	0.016	0.016	0.018
Al^{3+} /mgdm^{-3}	0.2	0.034	0.036	0.034	0.036	0.036	0.032	0.032	0.038	0.03	0.036
Mn^{2+} /mgdm^{-3}	0.1	0.024	0.026	0.028	0.026	0.026	0.026	0.026	0.024	0.028	0.026
NH_{4+} /mgdm^{-3}	0.5 (EU dir.)	0.058	0.056	0.054	0.054	0.054	0.054	0.056	0.064	0.058	0.062
NO_{2-} /mgdm^{-3}	3	0.0024	0.0026	0.0024	0.0026	0.0022	0.0022	0.002	0.0026	0.0026	0.0026
NO3- /mgdm^{-3}	50	0.56	0.56	0.54	0.54	0.54	0.56	0.54	0.56	0.54	0.54

Table 3. Basic statistical parameters for 12 variables in supply water of 5 sample stations

Variable	Unite	Descriptive statistics						
		Mean	Geo. Mean	Median	Min.	Max.	Variance	Std. Dev.
pH		7.2686	7.2683	7.3010	7.1760	7.3380	0.00415	0.064436
EC	/μScm−1	228.0600	227.9487	232.3000	217.2000	235.0000	55.85822	7.473836
Turbidity	/NTU	0.1247	0.1233	0.1270	0.0980	0.1500	0.00039	0.019640
Cons. of KMnO4	/mgdm-3	3.9380	3.9102	3.9200	3.3496	4.4872	0.24203	0.491969
Cl, residual	/mgdm-3	0.2680	0.2675	0.2800	0.2300	0.2800	0.00031	0.017512
Cl-	/mgdm-3	5.6096	5.6089	5.6380	5.4180	5.7120	0.00913	0.095526
Fe2+	/mgdm-3	0.0158	0.0157	0.0160	0.0120	0.0180	0.00000	0.001751
Al3+	/mgdm-3	0.0344	0.0343	0.0350	0.0300	0.0380	0.00001	0.002459

Mn3+	/mgdm-3	0.0260	0.0260	0.0260	0.0240	0.0280	0.00000	0.001333
NH4+	/mgdm-3	0.0570	0.0569	0.0560	0.0540	0.0640	0.00001	0.003559
NO2-	/mgdm-3	0.0024	0.0024	0.0025	0.0020	0.0026	0.00000	0.000220
NO3-	/mgdm-3	0.5480	0.5479	0.5400	0.5400	0.5600	0.00011	0.010328

Table 4. Matrix of correlation coefficients (r) of 12 variables

Variable	**pH**	**EC**	**Turbidity**	**Cons. of $KMnO_4$**	**Cl, resid.**	**Cl^-**	**Fe^{2+}**	**Al^{3+}**	**Mn^{3+}**	**NH_4^+**	**NO_2-**	**NO_3-**
pH	1.00											
EC	0.93	1.00										
Turbidity	0.55	0.30	1.00									
Cons. of $KMnO_4$	0.83	0.76	0.24	1.00								
Cl, resid.	-0.27	-0.29	-0.18	-0.12	1.00							
Cl^-	0.76	0.60	0.69	0.47	-0.42	1.00						
Fe^{2+}	-0.26	-0.29	-0.42	-0.17	-0.01	-0.32	1.00					
Al^{3+}	0.16	0.23	-0.27	0.37	-0.19	-0.35	0.33	1.00				
Mn^{3+}	-0.07	-0.12	0.22	-0.02	0.00	0.26	-0.38	-0.54	1.00			
NH_4^+	-0.76	-0.60	-0.72	-0.51	0.29	-0.94	0.39	0.36	-0.47	1.00		
NO_{2-}	-0.30	-0.07	-0.76	0.07	-0.28	-0.48	0.13	0.39	0.00	0.48	1.00	0.12
NO_{3-}	0.15	0.37	-0.32	0.02	-0.02	-0.05	-0.15	0.21	-0.65	0.24	0.12	1.00

Discussion of physico-chemical parameters of waters

In the present study were found that the pH of supply water varied from 7.176-7.338, with mean value ± standard deviation from 7.2686 ± 0.064 and It could be from composition of rocks in the area. EC varied from 217.2-235 μScm^{-1} with mean value ± standard deviation from 228.06±7.474 μScm^{-1}, Turbidity in water is because of suspended solids and colloidal matter. If sewage solids are present, pathogens may be encased in the particles and escape the action of chlorine during disinfection. Turbidity in our water samples varied from 0.098-0.15 NTU with mean value ± standard deviation from 0.1247 ± 0.0196 NTU, Cons. of $KMnO_4$ varied from 3.3496-4.4872 $mgdm^{-3}$ with mean value ± standard deviation from 3.938±0.492 $mgdm^{-3}$, and all samples were found to be under limit of recommended WHO standard for drinking water, residual Cl after chemical treatment during disinfection process, varied from 0.23-0.28 $mgdm^{-3}$ with mean value ± standard deviation from 0.268±0.0175 $mgdm^{-3}$, Cl^- ions varied from 5.418-5.712 $mgdm^{-3}$ with mean value ± standard deviation from 5.6096 ± 0.0955 $mgdm^{-3}$, Fe^{2+} ions varied from 0.012-0.018 mgdm^{-3}with mean value and standard deviation from 0.0158±0.00175 mgdm^{-3}, Al^{3+} ions was in range 0.03-0.038 mgdm^{-3}with mean value and standard deviation from 0.0344±0.00246 mgdm^{-3}. Mn^{2+} ions was ranged 0.024-0.028 mgdm^{-3}with mean value and standard deviation from 0.026±0.001333 mgdm^{-3}, NH_4^+ ions was ranged 0.054-0.064 mgdm^{-3} with mean value and standard deviation from 0.057 ± 0.003559 mgdm^{-3}, NO_2^- ions was ranging 0.002-0.0026 mgdm^{-3} with mean value and standard deviation from 0.0024±0.00022 mgdm^{-3}, NO_3^- ions was ranging 0.54-0.56 mgdm^{-3} with mean value and standard deviation from 0.548±0.0103 mgdm^{-3}. The concentration of ions: chloride, iron, aluminium, manganese, ammonia, nitrites and nitrates in all samples were found to be under recommended WHO standards for drinking water.(Fig. 2.)

Statistical interpretation of results

(a) Basic statistical parameters (Mean, Geometric mean, Median, Minimum, Maximum, Variance and Standard deviation) of 12 parameters analyzed in 5 sample stations are presented in Table 3. Scatter box plot diagrams for measured variables are presented in Fig, 2. Using experimental data from Tables 2 and 3 and box plot approach (Tukey, 1977), anomalous values (extremes and outliers) of 12 variables were determined. In water samples from May and October month, extremes value of Fe^{2+} (0.018 mgdm^{-3}) were registered, while in samples from March and September month, extremes value of Mn^{2+} (0.028 mgdm^{-3}) were registered.

(b) The statistical regression analysis has been found a highly useful technique for the linear correlating between various water parameters. The correlation coefficient indicates positive and negative significant correlation of variables with each other. Positive correlation mean one parameter increase with other parameters and negative correlation mean one parameter increase with other parameters decrease. Based on statistical regression analysis of water samples (Table 4), the result dates suggest a strong positive correlation of pH with EC (0.93), consumption of $KMnO_4$ (0.83), Turbidity (0.55), Cl^- (0.76), Al^{3+} (0.16) and NO_3^- (0.15). Result dates suggest also strong positive correlations of EC with Turbidity (0.30), consumption of $KMnO_4$ (0.76), Cl^- (0.23), Al^{3+} (0.23) and NO_3^- (0.37). The Turbidity was correlated with consumption of $KMnO_4$ (0.24), Cl^- (0.69) and Mn^{2+} (0.22). The consumption of $KMnO_4$ was correlated with Cl^- (0.47), Al^{3+} (0.37), NO_2^- (0.07) and NO_3^- (0.02). The residual Cl was correlated with NH_4^+ (0.29). Fe^{2+} ions were correlated with Al^{3+} (0.33), NH_4^+ (0.39) and NO_2^- (0.13). Al^{3+} ions were correlated with NH_4^+ (0.36) and NO_2^- (0.39). NH_4^+ ions were correlated with NO_2^- (0.48) and NO_3^- (0.24) and finaly NO_2^- ions were correlated with NO_3^- (0.12).

(c) Cluster analysis of R-mode (Fig. 3) showed mutual links between studied parameters. It could be observed on water samples that EC has closest linkages with consumption of $KMnO_4$ and they form first branch of the dendogram. This branch is linked with the other one, in which are linked with Cl^- and pH. Also EC

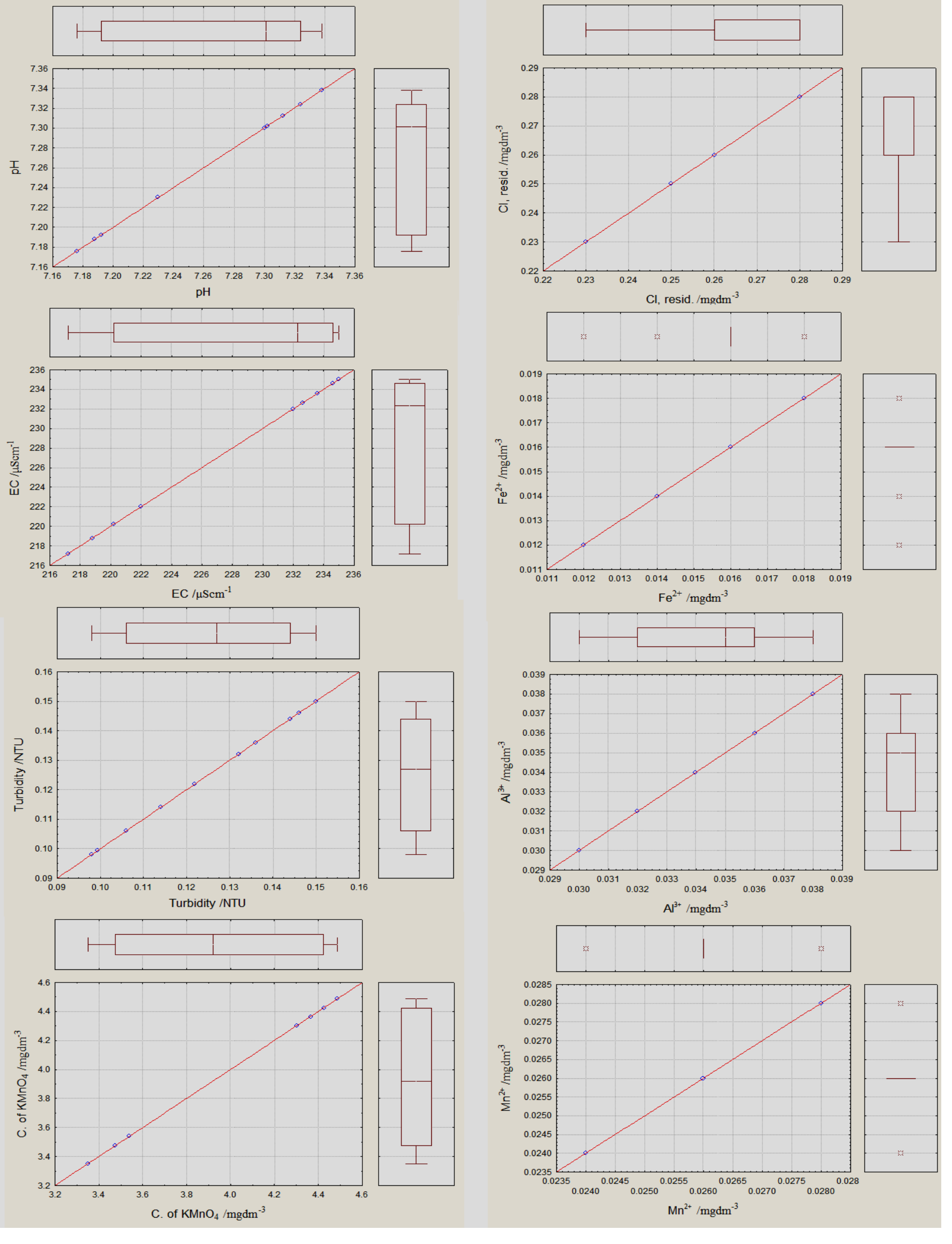

Fig. 2. Scatter box plot diagrams of 8 measured variables

has closest linkages with NO_3^- and they form second branch of the dendogram. This branch is linked with the other one, in which are linked with residual Cl, after which follow NO_2^-, Mn^{2+}, Al^{3+}, Fe^{2+} and Turbidity.

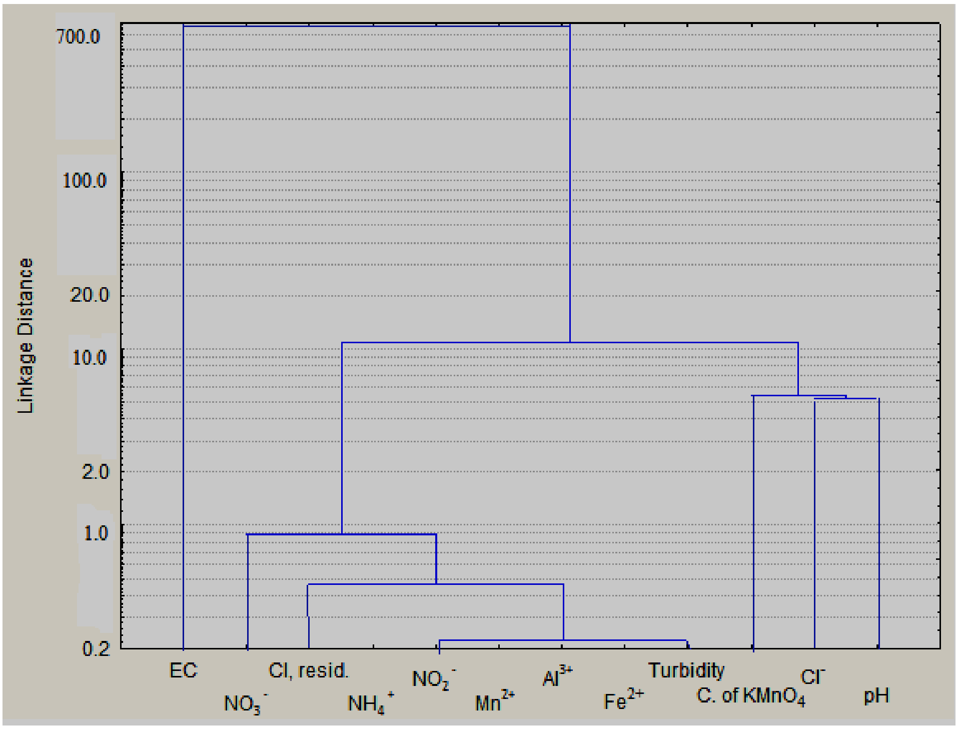

Fig. 3. Dendogram of measured variables in supply water samples

Conclusions

Generally, well waters of Kosovo are enriched in dissolved solids, as the consequence of aquifer lithology and residence time of ground water. In this study the quality assessment of supply water and correlation coefficients between different pairs of variables were investigated. From the results of field work and laboratory analyses it was found out that well water fulfill the criteria set by the WHO (the distribution of low pollutants indicated the lithological pollution) and the water was potable for consumption. The statistical regression analysis has been found a moderately high positive correlation relationship between pH and EC, consumption of $KMnO_4$, Turbidity, Cl^-, Al^{3+} and NO_3^-. Result dates suggest also strong positive correlations of EC with Turbidity, consumption of $KMnO_4$, Cl^-, Al^{3+} and NO_3^-. The Turbidity was correlated with consumption of $KMnO_4$, Cl^- and Mn^{2+}.

NOTES

1. http://www.who.int/water_sanitation_health/dwq/GDWQ2004web.pdf
2. https://www.mwa.co.th/download/file_upload/SMWW_1000-3000.pdf
3. http://www.statsoft.com/Portals/0/Products/PCA_Analysis_with_Statistica.pdf

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