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QUALITY ASSESSMENT AND CORRELATION COEFFICIENTS STUDY OF CHEMICAL DATA OF WELL WATERS IN THE NORTH EASTERN PART OF PRISHTINA (KOSOVA)

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ABSTRACT

The reaction between ground water and aquifer minerals affects ground water quality significantly, but is also useful to understand the genesis of ground water. Chemical contamination of groundwater has several implications for human health. In this study the aassessment of water quality after chemical treatment and correlation coefficients between different pairs of variables of 6 well water samples in the north eastern part of Prishtina were investigated. Statistical studies have been carried out by calculating of basic statistical parameters, anomalies (extremes and outliers) and correlation coefficients between different pairs of variables. The statistical regression analysis has been found a moderately high positive correlation relationship between EC with Dry residue, TDS and NO_2^-. Consumption of $KMnO_4$ showed a high positive correlation relationship with NO_2^- and Cl^- and a moderately high positive correlation relationship with HCO_3^-, CO_3^{2-} and NO_3^-. From the results of field work and laboratory analyses it was found out that well water not fulfill the criteria set by the World Health Organization and the distribution of pollutants indicated anthropogenic sources of pollutants; mainly from septic tanks, waste waters, using of chemical fertilizers and using of water purification which are extensively used in this area.

Keywords: quality assessment, correlation coefficients, well waters, prishtina, statistical analysis.

1. INTRODUCTION

The sources of physico-chemical 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, *et al.,* 1984). Chemical contamination of drinking water is often considered a lower priority than microbial contamination by regulators, because adverse health effects from chemical contaminations are generally associated with long-term exposures, whereas the effects from microbial contamination are usually immediate practices (Thompson *et al*., 2007). The quality of drinking water is an issue of primary interest for the residents of the European Union (Chirila *et 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 *et al.,* 2008). Decomposition of organic matter and pollution due to anthropogenic activity are the main sources of pollution of water (Montgomery, 1996). 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 (Kosovo Polje) and in Mitrovica. This was assumed to be caused by Zn and Pb processing by flotation and Zn-electrolysis factory. In Morava e Binçës River, two sites were found to be polluted with Cd. The authors of that paper suggested future monitoring of sediments and possibly remediation of Sitnica and Morava e Binçës Rivers. As Drenica River is the most important tributaryof 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) performed research of mass concentrations of ecotoxic metals: Cu(II), Pb(II), Cd(II), Zn(II) andMn(II) in waters of four main rivers 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

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Sitnica River as very polluted with ecotoxic elements and possible remediation by Kosovo authorities concerned was suggested. Troni *et al*. (2013) compared the surface water quality in Kosovo in Lumbardhi River basin in the region of Peja. From chemical aspects are investigated some of main indicators pollution as: pH value (in situ) dissolved oxygen, lead, cadmium, copper, zinc, arsenic, cobalt, nickel, uranium, bromine, nitrites, etc. The aim of the current work is to perform, a systematic research of the well water quality in the north eastern part of Prishtina (Figure-1 and Table-1).

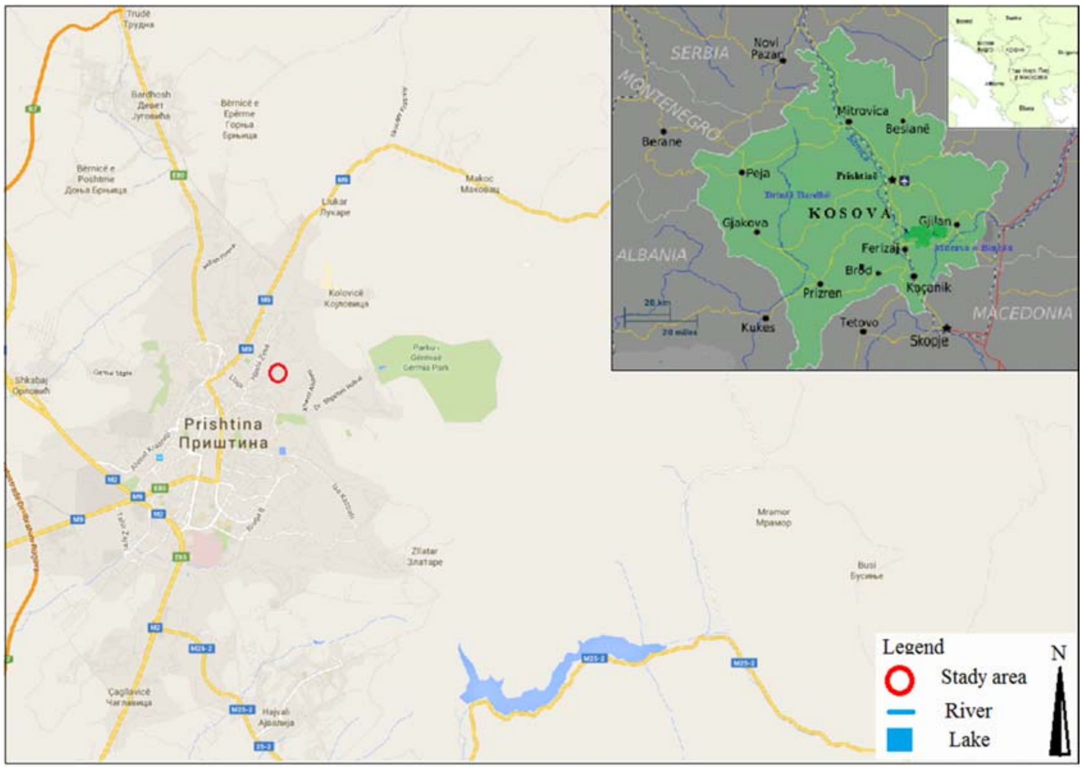

Figure-1. Area map with analysis location.

Table-1. Sampling stations with detailed locality description.

Sample	Coordinates	Height over sea/m	Surface water depth/m	Possible pollution sources
S_1	N 42.67225 E 021.17750	712.0	42	Settlement, septic tanks,
S_2	N 42.67313 E 021.17797	715.0	54	Settlement, septic tanks, waste waters
S_3	N 42.67317 E 021.17781	692.0	47	Settlement, septic tanks.
S_4	N 42.67316 E 021.17325	719.3	43	Settlement, septic tanks, waste waters
S_5	N 42.67314 E 021.17808	708.0	42	Settlement, septic tanks, the use of fertilizers.
S_6	N 42.67326 E 021.17719	722.0	40	Settlement, septic tanks.

2. MATERIALS AND METHODS

2.1 Study area

Prishtina is the capital and largest city of Kosovo located at the geographical coordinates 42° 40' 0" North and 21° 10' 0" East and covers 572 square kilometres. It lies in the north-eastern part of Kosovo close to the Gollak mountains (Wikipedia). 12 parameters are selected for our investigation. These parameters are: water temperature, conductivity, pH, consumption of $KMnO_4$, nitrate, nitrite, ammonia, etc. The results are interpreted using modern statistical methods that can be used to locate pollution sources. The levels of some physico-chemical parameters of well waters are compared with the World

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Health Organization statndards for drinking water (2004; 2011).

2.2 Sampling and sample preparation

For chemical analysis water samples are collected on May 29, 2012. Samples, previously were rinsed three times with sampled water, and labeled with the date and the name of the sample. 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 (APHA 1998; Alper *et al.,* 2003; Dalmacija 2000). Samples are preserved in refrigerator after treatment.

2.3 Chemical characterization

Double distilled water was used in all experiments. All instruments are calibrated according to manufacturer's recommendations. Temperature of water was measured immediately after sampling. TDS and 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 titration (acidimetry, alkalimetry, complexometry, argentometry and oxidoreduction) methods were defined concentration of chlorides and chemical consumption of $KMnO_4$ (Thiemann Küebel volumetric method, boiling in acidic environment). Concentrations of PO_4^{3-}, NO_2^-, NO_3^- and NH_4^+ were determined using UV-VIS spectrometry method, using "Merck Spectroquant NOVA 60 Fotomoter".

2.4 Statistical methods

Program Statistica 6.0 (Statsoft 2001) 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.

3. RESULTS AND DISCUSSIONS

The physico-chemical parameters of 6 well water samples, i.e. water temperature, EC, pH, TDS, consumption of $KMnO_4$, hardness, alkalinity, and concentrations of CO_3^{2-}, HCO_3^-, NH_4^+, NO_2^-, NO_3^-, Cl^-, PO_4^{3-}, Mg^{2+} and Ca^{2+} were presented in Table 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. **S**catter box plot diagrams of 15 measured variables are presented in Figure-2. Using experimental data (Table-2) and box plot approach of Tukey (1977), anomalous values (extremes and outliers) of 15 variables were determinate (Table-4). Correlation Pearson's factor for 12 variables was calculated to see if some of the parameters were interrelated with each other and the results are presented in Table-5.

3.1 Discussion of chemical parameters of well waters

In the present study, the temperature of 6 of well water samples varied from 12.5–13.5° C, as usual behavior of most of well waters. As thermostat adjustment of the instrument for conductivity measurement wasn't done, temperature of water sample was measured and with approximate correction factor, f, which for water, in temperature range from 10 to 25˚C, is 0.02˚C^{-1}, it was calculated to temperature of 20˚C by the equation:

$$\kappa_{20} = \kappa_t \left[1 + f\left(20 - t\right)\right]$$

Mean value of EC (846.43 µScm^{-1}), as sign of natural pollution, and were about two times higher than values measured value of Izbitac karstic spring on the slopes of Biokovo Mt. in Croatia (362.5 µScm^{-1}), which is known to be under the significant anthropogenic influence (Matić *et al*. 2012). The highest value of 1139 µScm^{-1} is measured at station S_4 as possible sign of anthropogenic influence. pH values were varied from 7.13-7.33 and It could be from composition of rocks in the area and anthropogenic pollution influence. Dry residue of the investigated samples was ranging from 236-922 mgL^{-1}. Stations S_2-S_6 was found to be above recommended World Health Organization standards for drinking water, as possible sign of anthropogenic influence. TDS values of all water samples ranged from 373-635 mgL^{-1} and not exceed recommended norms for drinking water. That higher value of consumption of $KMnO_4$ might be sign of anthropogenic pollution. Consumption of $KMnO_4$ was ranging from 67.73-99.04 mgL^{-1} and all samples were found to be above recommended norms for drinking water.

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Table-2. Some physico-chemical parameters of well waters.

Parameter	Unite	MPL, WHO	S_1	S_2	S_3	S_4	S_5	S_6
Water temp.	/º C	12	13.5	13	13	13.2	13.2	12.5
EC	/μScm^{-1}	1000	765	811	792	1139	936	702
pH	/1	6.5-8.5	7.26	7.30	7.26	7.13	7.25	7.33
Dry residue	/mgL^{-1}	550	480	604	526	922	726	236
TDS	/mgL^{-1}	1500	483	466	430	635	499	373
C. of $KMnO_4$	/mgL^{-1}	10	67.73	83.45	85.15	96.77	99.04	92.84
Hardness, totaly	/°d H	-	23.28	24.39	18.84	19.96	24.89	19.96
Alkalinity, totaly	/mgL^{-1}	80	82.85	82.46	98.89	74.11	84.86	96.49
CO_3^{2-}	/mgL^{-1}	-	154.94	210.94	341.72	206.77	286.09	316.10
HCO_3^-	/mgL^{-1}	635	142	210.5	240.34	208.62	199.47	218.38
NH_3	/mgL^{-1}	1.5	<0.001	<0.001	<0.001	0.051	<0.001	<0.001
NO_2^-	/mgL^{-1}	3	<0.001	0.01	0.021	0.068	0.053	0.039
NO_3^-	/mgL^{-1}	50	14	44	23	145	720	120
Cl^-	/mgL^{-1}	250	91.27	76.51	113.96	197.89	187.69	218.38
PO_4^{3-}	/mgL^{-1}	400	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mg^{2+}	/mgL^{-1}	150	51.3	31.26	28.70	45.86	11.35	14.71
Ca^{2+}	mgL^{-1}	200	118.92	127.13	96.24	104.03	132.56	106.18

Table-3. Basic statistical parameters for 15 variables in 6 well water samples.

Variable	Unite	Descriptive statistics						
		Mean	Geo. Mean	Median	Min.	Max.	Var.	Std. Dev.
Water temp.	/° C	13.0667	13.0631	13.100	12.5000	13.500	0.11	0.3327
EC	/μScm^{-1}	857.5000	846.4293	801.50	702.000	1139.0	24918.70	157.8566
pH	/1	7.2550	7.2547	7.2600	7.1300	7.330	0.00	0.0683
Dry residue	/mgL	582.3333	537.4119	565.00	236.000	922.00	54015.07	232.4114
TDS	/mgL	481.0000	474.6762	474.50	373.000	635.00	7706.80	87.7884
Cons. of $KMnO_4$	/mgL^{-1}	87.4967	86.8187	88.995	67.7300	99.040	132.08	11.4926
Hardness, totaly	/°d H	21.8867	21.7572	21.620	18.8400	24.890	6.79	2.6052
Alkalinity, total	/mgL^{-1}	86.6100	86.1903	83.855	74.1100	98.890	87.82	9.3711
CO_3^{2-}	/mgL^{-1}	252.7600	243.5761	248.515	154.940	341.72	5293.89	72.7592
HCO_3^-	/mgL^{-1}	203.2183	200.6637	209.560	142.000	240.34	1090.37	33.0207
NO_2^-	/mgL	0.0320	0.0176	0.0300	0.0010	0.068	0.00	0.0259
NO_3^-	/mgL	177.6667	74.9661	82.0000	14.0000	720.00	73418.67	270.9588
Cl-	/mgL	147.6167	136.4518	150.825	76.5100	218.38	3700.92	60.8352
Mg^{2+}	/mgL	30.5300	26.5769	29.9800	11.3500	51.300	257.69	16.0526
Ca^{2+}	/mgL	114.1767	113.4346	112.550	96.2400	132.56	203.37	14.2609

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Table-4. Anomalous values (extremes and outliers) determined in well waters.

Sample	Extremes of parameters (¤)	Outliers of parameters (o)
S_1	No reg.	No reg.
S_2	No reg.	No reg.
S_3	No reg.	HCO_3^- (240.34 mgL^{-1})
S_4	No reg.	TDS (635 mgL^{-1})
S_5	NO_3^- (720 mgL^{-1})	No reg.
S_6	No reg.	No reg.

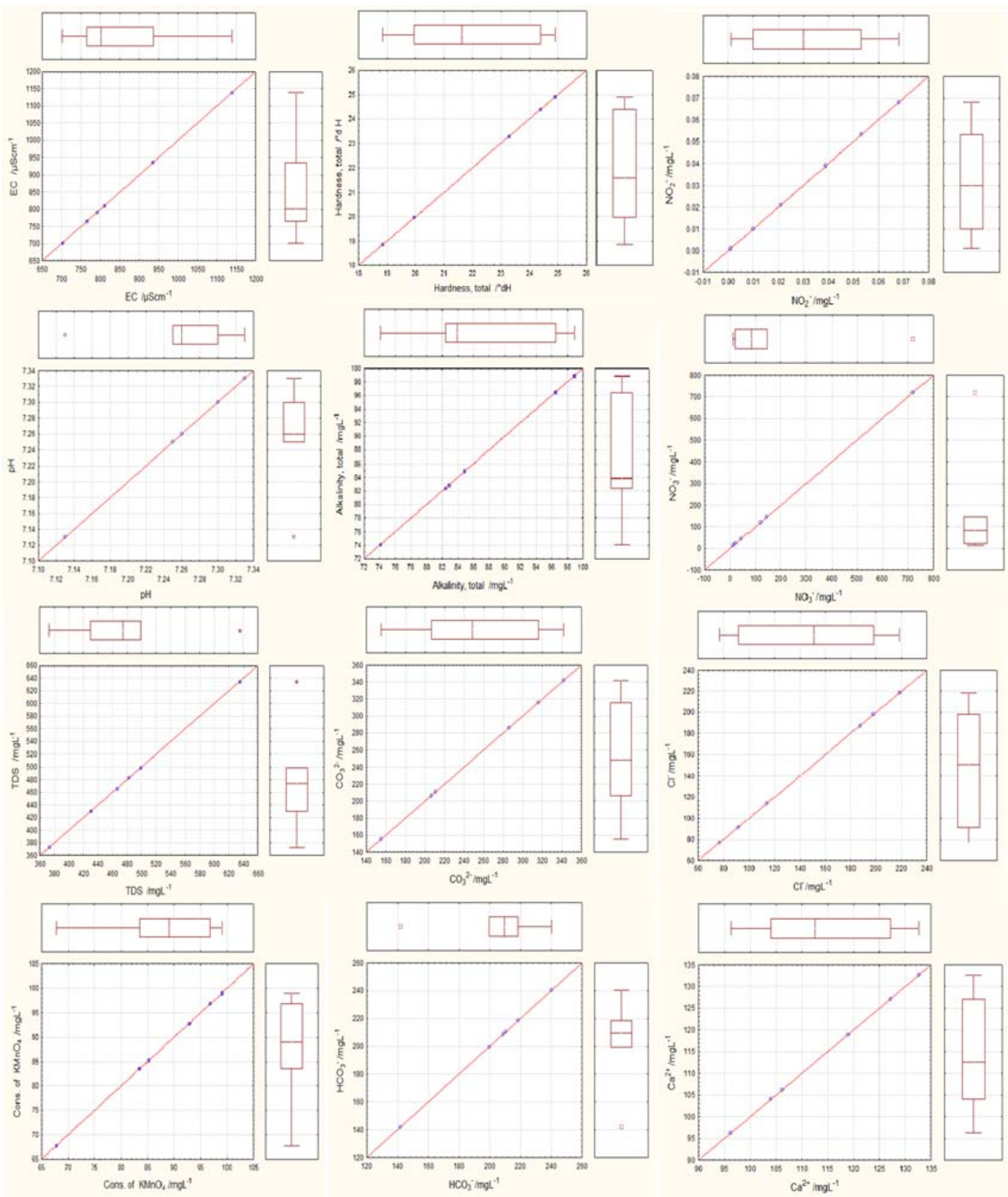

Figure-2. Scatter box plot diagrams of 12 measured variables.

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Table-5. Matrix of correlation coefficients (r) of selected 15 variables.

Variable	W. temp.	EC	pH	Dry res.	TDS	Cons. of $KMnO_4$	Hardnes, totaly	Alkalini, totaly	CO_3^{2-}	HCO_3^-	NO_2^-	NO_3^-	Cl-	Mg^{2+}	Ca^{2+}
Water temp.	1.00														
EC	0.39	1.00													
pH	-0.54	-0.93	1.00												
Dry residue	0.57	0.94	-0.87	1.00											
TDS	0.61	0.94	-0.95	0.93	1.00										
Cons. of $KMnO_4$	-0.44	0.54	-0.28	0.38	0.24	1.00									
Hardness, totaly	0.43	-0.03	0.21	0.17	0.08	-0.16	1.00								
Alkalinity, total	-0.62	-0.74	0.68	-0.76	-0.87	-0.04	-0.44	1.00							
CO_3^{2-}	-0.69	-0.26	0.34	-0.34	-0.55	0.52	-0.47	0.81	1.00						
HCO_3^-	-0.69	0.07	0.06	0.01	-0.21	0.62	-0.54	0.48	0.80	1.00					
NO_2^-	-0.18	0.75	-0.60	0.54	0.53	0.90	-0.25	-0.28	0.26	0.36	1.00				
NO_3^-	0.11	0.35	-0.11	0.35	0.17	0.63	0.48	-0.14	0.24	0.00	0.56	1.00			
Cl-	-0.45	0.35	-0.23	0.06	0.13	0.80	-0.34	0.03	0.41	0.29	0.87	0.48	1.00		
Mg^{2+}	0.66	0.27	-0.52	0.32	0.55	-0.62	-0.10	-0.56	-0.78	-0.54	-0.29	-0.61	-0.47	1.00	
Ca^{2+}	0.34	-0.00	0.22	0.17	0.06	-0.04	0.99	-0.41	-0.39	-0.47	-0.15	0.57	-0.21	-0.21	1.00

Total alkalinity was ranging from 74.11-98.89mgL^{-1} and stations S_1-S_3, S_5 and S_6 were found to be above recommended WHO standards for drinking water (calc. as $CaCO_3$, 80 mgL^{-1}). Concentration of CO_3^{2-} was ranging from 154.94-341.72 mgL^{-1}. Concentration of HCO_3^- was ranging from 142-240.34 mgL^{-1} and all stations were found to be under recommended WHO standards for drinking water (MPV, 635 mgL^{-1}), what could be due to carbonate abundance around this location. Total hardness was ranging from 18.8-24.89° dH und were found to be under recommended standards for drinking water (30° dH). Increased hardness on those locations is of natural origin, due to presence of chalk limestone gravel deposits.

Concentrations of ammonia, nitrites, chlorides, magnesium and calcium in all samples were found to be under recommended WHO standards for drinking water. Phosphates were not detected. Concentration of nitrates was ranging from 14-720 mgL^{-1} and stations S_4-S_6 were found to be above recommended WHO standards for drinking water, as possible sign of anthropogenic influence (agricultural land use and wastewaters).

Basic statistical parameters (Mean, Geometric mean, Median, Minimum, Maximum, Variance and Standard deviation) for 15 parameters analyzed in 6 water samples are presented in Table 3. Based on the two dimensional scatter box plot diagrams (Figure-2) from experimantal data were constructed and anomalous values (extremes and outliers) were registered in Table-4. In the sample S_3 outlier value of HCO_3^- (240.34 mgL^{-1}) was registered, what could be due to carbonate abundance around this location? In the sample S_5 outlier value of TDS was registered. In the sample station S_5 extreme value of NO_3^- (720mgL^{-1}) was registered, as possible sign of agricultural land use and wastewaters.

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.

In study period, EC (Table-5) showed a moderately high positive correlation relationship with Dry residue, TDS and NO_2^-. No correlation was found with pH and alkalinity. pH showed a high positive correlation relationship with alkalinity. Dry residue showed a moderately high positive correlation relationship with TDS and moderately high positive correlation relationship with consumption of $KMnO_4$, Mg^{2+}, NO_3^- and NO_2^-. TDS showed a moderately high positive correlation relationship with consumption of $KMnO_4$, $Mg^{2+}$and NO_2^-. Consumption of $KMnO_4$ showed a high positive correlation relationship with NO_2^- and Cl^- and a moderately high positive correlation relationship with HCO_3^-, CO_3^{2-} and NO_3^-. Hardness showed a high positive correlation relationship with Ca^{2+} and a moderately high positive correlation relationship with NO_3^-. Alkalinity showed a high positive correlation relationship with CO_3^{2-} and a moderately high positive correlation relationship with HCO_3^-. CO_3^{2-} showed a high positive correlation relationship with HCO_3^- and a moderately high positive correlation relationship with Cl^-, NO_3^- and NO_2. HCO_3^- showed a moderately high positive correlation relationship

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with Cl^- and NO_2.The nitrite ion showed a moderately high positive correlation relationship with nitrates and chlorides. The nitrate ion showed a moderately high positive correlation relationship with chlorides.

Chemical data from the Table-3 can be used for the assessment of water contamination according with WHO standards for drinking water. Results are also compared with available results of four similar well waters in Kosovo (Istog, Lipjan city, Lipjan (west) and Mirosala (Gashi *et al*., 2015, 2016a, 2016b, 2016c).

When concentrations of 16 selected measured parameters in well waters of Prishtina (see Table-6) are compared with similar well waters in Kosovo, following facts can be observed: electrical conductivity in well waters of Prishtina were significantly higher than in well waters of Istog and Mirosala, but are approximately the same as in well waters of Lipjan. pH in well waters of Prishtina were significantly higher than in well waters of Lipjan and lower than in well waters of Mirosala. pH are approximately the same as in spring and well waters of Istog. Dry residue in well waters of Prishtina were significantly higher than in well waters of Lipjan.TDS were approximately the same as in well waters of Istog, Lipjan and Mirosala. Consumption of $KMnO_4$ were significantly higher than in well waters of Mirosala and lower than in well waters of Lipjan (west).

Consumption of $KMnO_4$ approximately the same as in well waters of Lipjan.Total Hardness of water were significantly higher than in well waters of Lipjan and Mirosala and approximately the same as in spring and well waters of Istog.

Total alkalinity were about 2 times higher than in spring and well water of Istog and and more than 4 times higher than in waters of Lipjan. CO_3^{2-} concentrations in water of Prishtina were significantly higher than in well water in west of Lipjan. HCO_3^- concentrationsre are significantly higher than in spring and well waters of Istog and Mirosal and approximately the same as in spring and well waters of Lipjan. NH_3 concentrationsre were significantly lower (below the limit of detection, LOD) than in spring and well waters of Istog. NO_2^- concentrations were approximately the same as in spring and well waters of Istog and Mirosala. Cl^- concentrations were significantly higher than in well water in spring and well waters of Istog and Mirosala and approximately the same as in well waters of Lipjan (west). Concentrations of chlorides were about 3 times higher than in waters Lipjan. PO_4^{3-} concentrations were significantly lower (below the limit of detection, LOD) than in spring and well waters of Istog. Mg^{2+} concentrations were significantly higher than well waters of Lipjan and approximately the same as in well waters of Lipjan (west), Istog and Mirosala. Ca^{2+} concentrations were significantly higher than in well waters of Istog, Lipjan and Mirosala.

Finally, it can be summarized that value of 16 parameters of well waters in Prishtina were approximately the same, slightly/significantly higher than in the well waters used for comparison.

Table-6. Comparison of 16 parameters in well waters of Prishtina (this work) with concentrations in similar well waters in Kosovo, from the literature and with WHO Drinking water standards (2004, 2011).

Parameter	Unite	MPL, WHO	Prishtina well (min-max)	Istog well (Mean)	Lipjan well (Mean)	Lipjan (west) well (Mean)	Mirosala well (Mean)
EC	/μScm^{-1}	1000	702-1139	696.304	1029.1	1218.5	475.5
pH	-	6.5-8.5	7.13-7.33	7.2	6.86	6.876	7.98
Dry residue	/mgL^{-1}	550	236--922	-	762.79	205.438	-
TDS	/mgL^{-1}	1500	373-635	348.35	576.6	632.875	-
C. of $KMnO_4$	/mgL^{-1}	10	67.7-99.04	-	78.512	110.614	10.7133
Hardness, totaly	/°d H	-	18.84-24.89	19.24	4.076	5.18	10.8283
Alkalinity, totaly	/mgL^{-1}	80	74.11-98.89	39.96	20.74	-	-
CO_3^{2-}	/mgL^{-1}	-	154.94-341.72	-	18.53	507.725	-
HCO_3^-	/mgL^{-1}	635	142-240.34	351.16	-	188.905	304.5833
NH_3	/mgL^{-1}	1.5	<0.001	2.372	-	-	-
NO_2^-	/mgL^{-1}	3	0.001-0.068	0.0617	-	-	0.0218
NO_3^-	/mgL^{-1}	50	14-720	19.04	-	-	0.2133
Cl^-	/mgL^{-1}	250	76.51-218	24.63	736.78	125.550	16.2593
PO_4^{3-}	/mgL^{-1}	400	<0.001	0.2927	-	-	-
Mg^{2+}	/mgL^{-1}	150	11.35-51.3	33.37	3.56	18.726	24.375
Ca^{2+}	mgL^{-1}	200	96.24-132.56	85.313	23.72	37.450	39.4033

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4. 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 assessment of water quality and correlation coefficients between different pairs of variables of well water in the north eastern part of Prishtina were investigated. The statistical regression analysis has been found a moderately high positive correlation relationship between EC with Dry residue, TDS and NO_2^-. Dry residue showed a moderately high positive correlation relationship with TDS and moderately high positive correlation relationship with consumption of $KMnO_4$, Mg^{2+}, NO_3^- and NO_2^-. TDS showed a moderately high positive correlation relationship with consumption of $KMnO_4$, $Mg^{2+}$and NO_2^-.

From the results of field work and laboratory analyses it was found out that only well water samples not fulfill the World Health Organization criteria set for drinking water. This indicates that well waters of this area don't have "good status" and are continuously endangered by chemical pollution, mainly from septic tanks, waste waters, using of chemical fertilizers and using of water purification which are extensively used in this area. Therefore, continuous monitoring of waters of studied wells is strongly advised, as well as treatment of waters before being used for drinking.

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