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DETERMINING THE DRINKING WATER QUALITY IN SEVERAL RURAL SETTLEMENTS IN FERIZAJ MUNICIPALITY, KOSOVA

KOSOVA FERZOVİK BELEDİYESİ'NİN BİRKAÇ KIRSAL ALANINDA İÇME SUYU KALİTESİNİN BELİRLENMESİ

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ABSTRACT

Suspicions of diverse pollution of groundwater in the villages of Dremjak, Talinoc i Muhaxherve, Softaj, Gërlicë and Varosh of the Ferizaj municipality motivated the investigation of empirical quality of the water wells from which the inhabitants of the villages provided drinking water. Considering that drinking water is the basic element for humans to live, its testing prior to consumption is necessary, therefore, this groundwater is the focus of this research. The samples were taken from the pumping stations, where underground waters were collected. The water was tested for organoleptic, physicochemical, and microbiological parameters, and during the analysis the classical analytical and instrumental methods were applied. The results of the analyses were compared with the Administrative Directive No. 16/2012 of Kosovo and the Instruction No. 98/83 of the EU, based on the standard values of the water quality consumed by humans. Both are in line with the standards of the World Health Organization for drinking water quality. It was determined that the groundwater in the respective five villages was contaminated with heavy metals (Fe, Pb, Mn, Cd and Ni). The water samples taken for analysis based on the underground map of the region show that the underground layers contain metals to some extent. Therefore, the presence of such metals in water is due to geological pollution. However, other organoleptic, physico-chemical and microbiological parameters are compatible with reference values.

Anahtar Sözcükler:
İçme suyu,
Su kalitesi,
Ferzovik köyleri,
Ağır maddeler.

ÖZ

Ferzovik belediyesinin Dremjak, Talinoc i Muhaxherve, Softaj, Gërlicë ve Varosh köylerindeki yer altı sularının farklı yönde kirletildiğine dair edinilen şüpheler, ilgili köylerde yaşayan sakinlerin içme suyunu sağladıkları su kuyularının ampirik olarak kalitelerinin belirlenmesi amacıyla araştırılmasını motive etmiştir. İçme suyunun insanların yaşaması için temel unsur olduğu düşünüldüğünde, tüketimden önce test edilmesi gereklidir, bu nedenle bu yeraltı suyu bu araştırmanın odak noktasıdır. Örnekler, yeraltı sularının toplandığı pompa istasyonlarından alınmıştır. Su, organoleptik, fizikokimyasal ve mikrobiyolojik parametreler açısından test edilmiş ve analiz sırasında klasik analitik ve enstrümantal yöntemler uygulanmıştır. Analiz sonuçları, insan tarafından tüketilen su kalitesinin standart değerleri baz alınarak Kosova'nın 16/2012 No'lu İdari Yönergesi ve AB'nin 98/83 No'lu Talimatı'yla karşılaştırılmıştır. Her ikisi de Dünya Sağlık Örgütü'nün içme suyu kalitesinin standartlarıyla uyumludur. İlgili beş köyde yer altı sularının ağır metallerle (Fe, Pb, Mn, Cd ve Ni) kirletilmiş olduğu belirlenmiştir. Bölgenin yeraltı haritasına dayanarak analiz için alınmış su örnekleri, yer altı tabakalarının belli ölçüde metalleri içerdiğini göstermektedir. Dolayısıyla, bu tür metallerin sularda bulunması jeolojik kirlilikten kaynaklanmaktadır. Halbuki, diğer organoleptik, fiziko-kimyasal ve mikrobiyolojik parametreler referans değerleriyle uyumludur.

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INTRODUCTION

It is known that the main worry and preoccupation for humanity is, not only environment care and protection, but also to care for protecting the drinking water from various and many contaminators. The main pollution cause are humans themselves, their relationship with nature and environment in general, because of all-natural resources, water is the most important and should be the most precious. Water is a major natural source and basic human need for life. In recent decades, groundwater has become an essential resource due to its purity and availability (Verma et al., 2013).

Life was started by the water and is nourished by it, because no living organism can live without it. For this reason, since ancient time humans have constructed their settlements near drinking waters. In this context, springs were largely responsible for determining the sites of ancient settlements (Meuli and Wehrle, 2001).

Therefore, just as in the past, also today, and especially for the future ensuring sufficient water constitutes a serious preoccupation for humanity in general. Therefore, humanity today is aware of the fact that the biggest and most serious threat to human wellbeing is not the climate change nor various diseases, but rather obtaining sufficient drinking water, which in not always certain in the nature. Groundwater presumed to be naturally protected, it is considered to be free from impurities, which are associated with surface water, because it comes from deeper parts of the earth. Its quality is significantly affected by geologic formations of aquifers as well as by anthropogenic activities (Thomas, 2000).

The increase of water usage, due to the increasing of population, is accompanied by the reduction of reserves and the contamination of drinking water and natural water (Çullaj, 2010). The water quality in the world has experienced in recent years a deterioration because uncontrolled industrial discharges, intensive use of chemical fertilizers in agriculture well as disorderly exploitation of water resources (Gemitzi et al., 2006).

Therefore, for assessing the drinking water quality, it is appropriate and advisable to conduct monitoring based on the organoleptic physicochemical and microbiological parameters. The physicochemical quality of drinking water is also based on hydrogeological criteria. These criteria relate to the type of water layer feeding, the composition and structure of the terrain, the level of protection of the water layer etc. Fawell and Nieuwenhuijsen, 2003).

Numerous scientific researchers conducted in locations around the world have proven that half of the world (especially developing countries) suffer from various dangerous diseases caused by the consumption of water contaminated by various microbes and minerals. Water containing microorganisms spreads various microbe epidemics and infections. Therefore, it is necessary to find various methods for the ordinary examination of drinking water, for the purpose of determining the presence or non-presence of feces. In fact, checking drinking water for all pathogenic microorganisms that may spread through it is not practiced (Regli, 2007).

Water is seriously contaminated by toxic substances such as: heavy metals, pesticides, polycyclic aromatic hydrocarbons, etc. Heavy metals may get through on drinking water sources, in food products and due to their high toxicity can cause serious consequences to human health, therefore, it is necessary that their presence is maintained always under control (Çullaj, 2010).

For the record, the town of Ferizaj constitutes the municipal and regional center located in the southern part of Kosovo, its center being at 42°22’80’’ of northern latitude and 21°09’12’’ of eastern longitude, at an average altitude of 850m. Ferizaj Municipality, with the surrounding villages has an area of 345 km². The average annual temperature in Ferizaj Municipality is 10^0 C, and 9^oC in the mountains. The hottest months are July and August with an average temperature of 20.6 and 20.5^oC, and the coldest is January with -1.4^oC. The precipitation in this region is spread unequally. The average annual amounts vary at circa 673.3 mm in Ferizaj, according to IHMK data. The highest precipitation value is in May at 105.6 mm and the lowest in August at 42.2 mm (Plani I Zhvillimit Komunal. 2017-2025 i Komunës së Ferizajt, 2017).

Therefore, through this paper, we aim to present and confirm the quality of underground water in

Dremjak, Talinoc i Muhaxherve, Softaj, Gërlicë and Varosh villages wells, which administratively belong to Ferizaj Municipality.

1. MATERIALS AND METHODS

Samples for analyzing the underground drinking groundwater was taken in five different villages of Ferizaj Municipality, which are presented in Table 1 with coordinates.

Table 1. Sampling points and their coordinates

Sample number	Sampling point	Latitude	Longitude	Altitude (m)
M_1	Dremjak	4223'08" N	2104'20" E	635
M_2	Talinoc i Muhaxherëve	4223'33" N	2110'29" E	571
M_3	Softaj	4224'35" N	2112'10" E	583
M_4	Gërlicë	4219'27" N	2112'2" E	592
M_5	Varosh	4220'32" N	2110'35" E	540

The samples were taken at the pumping stations, where the groundwater is collected, and then through the piping system this water is distributed to these villages. The groundwater monitoring points were taken in the following villages: village Dremjak (M1), village Talinoc i Muhaxherëve (M2), village Softaj (M3), village Gërlicë (M4) and village Varosh (M5).

Groundwater monitoring network in these five villages of Ferizaj is presented on the map (Figure 1)

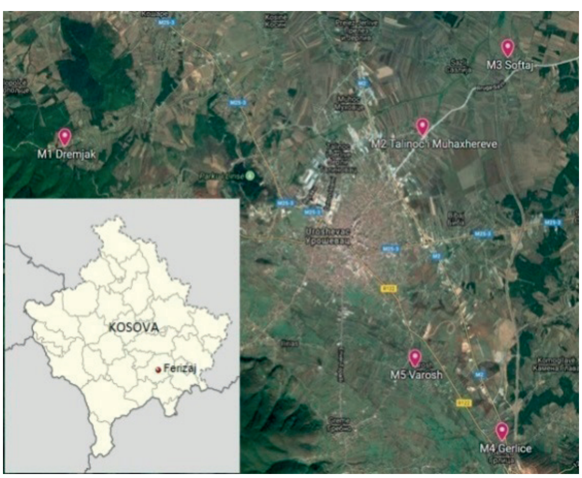

Figure 1. Underground drinking water net

Sampling is of special importance because it is causally related with the accuracy of the results, therefore extra care should be taken while sampling. The mode of sampling, the amount of sample taken and the mode of transport and the maximum time that the sample can stay before chemical analysis is conducted, have been made in accordance with the method's ISO (ISO 5667: 1,3,11).

Their conservation was done in compliance with the conservation procedure of the American Public Health Association, 2005 (APHA, 2005).

During this research, the comparative and visual method was applied to determine organoleptic parameters such as: smell, taste and color, whereas for specifying the physicochemical parameters, at the test lab the following methods were used: potentiometric method - pH value and electrical conductivity; nephelometric method - turbidity; spectrophotometric - ammonia, nitrites, nitrates and Al; and volumetric (titrimetric) method - expenditure of $KMnO_4$ and chlorides.

The standard methods applied to analyze each parameter are: pH-ISO 10523:2008; electrical conductivity (ISO 7888:1985); turbidity (ISO 7027:1999); ammonia (ISO 71505:1986); nitrites (ISO 6777:1984); nitrates (ISO 7890-3:1988); expenditure of (KMnO4), (ISO 8467:1993); chlorides (ISO 9297:1989); Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn, (ISO 15586:2003); Na and K, (ISO 16995:2015).

The microbiological analysis, determining the general number of live bacteria with PCA, was performed pursuant to the EN (ISO 6222:1999) standard.

Preparation of water samples to measure the heavy metals is based on the mineralization of samples by applying the EPA 3015A (US EPA 1994) methods, whereas to determine the concentration of heavy metals in water the SAA-Atomic Absorption Spectrophotometer measuring technique was applied (Perkin Elmer Analyst 400 Atomic Absorption Spectrophotometer), at the environmental analysis lab of the Hidro-Meteorological Institute of Kosova IHMK in Prishtinë.

2. RESULTS AND DISCUSSIONS

The results of organoleptic, physicochemical and microbiological analysis, for monitored sampling points, M_1, M_2, M_3, M_4, M_5 are presented in Table 2 for November 2018, Table 3 for December 2018 and Table 4 for May 2019, Table 5 for June 2019. Whereas, Table 6 contains the values of heavy metals for September 2019.

At this part of the research we have presented the results of the five samples analyzed for the organoleptic, physicochemical and microbiological analysis, taken at the five pumping stations, in five different villages as also presented in the distribution of monitoring points figure (Figure 1).

AI 16/2012 (referring values pursuant to Administrative Instruction 16/2012 of Kosovo)

The monitoring was conducted during November and December 2018 and May and June 2019 for the organoleptic, physicochemical, and microbiological parameters, whereas the heavy metals were analyzed only during September 2019. The physicochemical and microbiological parameters were analyzed at the Public Health Institute in Ferizaj, whereas the heavy metals were analyzed at the Hydrometeorological Institute of Kosovo in Prishtinë.

The results of the samples, presented under Tables 2-6, in relation to the organoleptic,

Table 2. Results of organoleptic, physicochemical and microbiological analysis (November 2018)

November 2018	Unit	AI 16/ 2012	M_1	M_2	M_3	M_4	M_5
Organoleptic parameters							
Smell		None	None	None	None	None	None
Taste		None	None	None	None	None	None
Color		None	None	None	None	None	None
Physic-chemical parameters							
Free chloride (residual)	mg/l	0.2-0.5	0.035	0.021	0.03	0.025	0.033
Turbidity	NTU	2	0.2	0.5	0.59	0.7	0.4
Aluminum	mg/l	0.2	-	-	-	-	-
pH value			7.23	7.45	7.58	7.21	7.7
Expenditure of	mg/l	5	0.39	0.32	0.55	0.8	0.64
Chlorides	mg/l	250	21.45	50.41	31.95	6.04	11.01
Ammonia	mg/l	0.5	0.04	0.0128	0.038	0.089	0.01
Nitrites	mg/l	0.5	0.01	0.071	0.023	0.032	0.03
Nitrates	mg/l	50	-	-	-	-	-
Electrical conductivity	μS/cm	2500	470	818	700	425	393
Microbiological parameters							
Total number of coliform bacteria	Number 100ml	0	0	0	0	0	0
Escherichia Coli	Number 100ml	0	0	0	0	0	0
Number of colonies in 37	Number 100ml	100	0	0	0	0	0

physicochemical and microbiological parameters, at all sampling points are fully compliant with the referring values based on Administrative Instruction 12/2016 of Kosovo (UA 16/2012) on the human consume water quality for human consumption, which is in correlation with EU Directive 98/83, (EU 1998) and the WHO (WHO 2011) on the drinking water quality.

Table 3. Results of organoleptic, physicochemical and microbiological analysis (December 2018)

December 2018	Unit	AI 16/ 2012	M_1	M_2	M_3	M_4	M_5
Organoleptic parameters							
Smell		None	None	None	None	None	None
Taste		None	None	None	None	None	None
Color		None	None	None	None	None	None
Physic-chemical parameters							
Free chloride (residual)	mg/l	0.2-0.5	0.039	0.018	0.035	0.015	0.3
Turbidity	NTU	2	0.22	1	0.55	0.2	0
Aluminum	mg/l	0.2	-	-	-	-	0
pH value			7.4	7.9	7.62	7.96	7.4
Expenditure of	mg/l	5	0.43	0.32	0.65	0.4	0.48
Chlorides	mg/l	250	19.5	53.96	33.25	12.07	6.39
Ammonia	mg/l	0.5	0.03	0.0128	0.02	0.0128	0.0128
Nitrites	mg/l	0.5	0.009	0.0113	0.021	0.00341	-
Nitrates	mg/l	50	-	-	-	-	-
Electrical conductivity	μS/cm	2500	499	755	688	389	195
Microbiological parameters							
Total number of coliform bacteria	Number 100ml	0	0	0	0	0	0
Escherichia Coli	Number 100ml	0	0	0	0	0	0
Number of colonies in 37	Number 100ml	100	0	0	0	0	0

Table 4. Results of organoleptic, physicochemical and microbiological analysis (May 2019)

May 2019	Unit	AI 16/ 2012	M_1	M_2	M_3	M_4	M_5
			Organoleptic parameters				
Smell		None	None	None	None	None	None
Taste		None	None	None	None	None	None
Color		None	None	None	None	None	None
			Physic-chemical parameters				
Free chloride (residual)	mg/l	0.2-0.5	0.037	0.11	0.07	0.04	0.6
Turbidity	NTU	2	0.4	0.55	0.35	0.64	0.32
Aluminum	mg/l	0.2	-	-	-	-	-
pH value			7.43	7.7	7.4	7.55	7.31
Expenditure of	mg/l	5	0.66	0.62	0.99	0.65	0.73
Chlorides	mg/l	250	283	44.11	8.88	29.88	9.18
Ammonia	mg/l	0.5	0.02	0.005	0.1	0.009	0.003
Nitrites	mg/l	0.5	0.008	0.018	0.038	0.0078	0.001
Nitrates	mg/l	50	-	-	-	-	-
Electrical conductivity	μS/cm	2500	355	529	677	402	265
			Microbiological parameters				
Total number of coliform bacteria	Number 100ml	0	0	0	0	0	0
Escherichia Coli	Number 100ml	0	0	0	0	0	0
Number of colonies in 37	Number 100ml	100	0	0	0	0	0

Table 5. Results of organoleptic, physicochemical and microbiological analysis (June 2019)

June 2019	Unit	AI 16/ 2012	M_1	M_2	M_3	M_4	M_5
			Organoleptic parameters				
Smell		None	None	None	None	None	None
Taste		None	None	None	None	None	None
Color		None	None	None	None	None	None
			Physic-chemical parameters				
Free chloride (residual)	mg/l	0.2-0.5	0.02	0.022	0.035	0.06	0.48
Turbidity	NTU	2	0.4	0.7	0.55	0.33	0.12
Aluminum	mg/l	0.2	-	-	-	-	0
pH value			7.46	7.6	7.69	7.48	7.22
Expenditure of	mg/l	5	0.88	0.42	0.66	0.45	0.33
Chlorides	mg/l	250	25.9	33.96	39.25	34.07	9.22
Ammonia	mg/l	0.5	0.009	0.0045	0.022	0.02	0.009
Nitrites	mg/l	0.5	0.01	0.01	0.018	0.006	0.002
Nitrates	mg/l	50	-	-	-	-	-
Electrical conductivity	µS/cm	2500	389	666	711	388	222
			Microbiological parameters				
Total number of coliform bacteria	Number 100ml	0	0	0	0	0	0
Escherichia Coli	Number 100ml	0	0	0	0	0	0
Number of colonies in 37	Number 100ml	100	0	0	0	0	0

Pertaining to the heavy metals, whose results we have presented in Table 6, the situation is as follows: at sampling point M1 we did not encounter any exceeding of the referring values of heavy metals Fe, Cd, Pb, Mn and Ni, the same situation applies to all sampling points pertaining to the concentration of Cr, Zn, Cu, Na and K.

Table 6. Heavy metals results for September 2019

Samples	Fe	Cd	Pb	Mn	Ni	Cr	Zn	Cu	Na	K
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	0.001	<0.001	<0.002	0.006	0.011	0.027	0.047	0.051	5.783	1.085
	0.017	0.007	<0.002	0.185	<0.006	0.028	<0.001	0.039	68.8	0.624
	0.086	0.003	<0.002	1.254	0.040	0.023	0.038	0.062	142.9	1.077
	0.219	<0.001	0.103	0.290	<0.006	0.044	0.025	0.048	11.850	0.476
	0.017	<0.001	0.114	0.034	0.041	0.027	<0.001	0.047	5.734	0.452
EU (1998) WHO(2011)	0.200	0.003	0.010	0.050	0.020	0.050	-	2	200	12

The graphical presentation of values exceeding the permitted limits, pursuant to EU Directive (EU, 1998) and WHO (WHO, 2011), iron in Figure 2, cadmium in Figure 3, lead in Figure 4, manganese in Figure 5, nickel in Figure 6. and common graph of metal concentration in Figure 7.

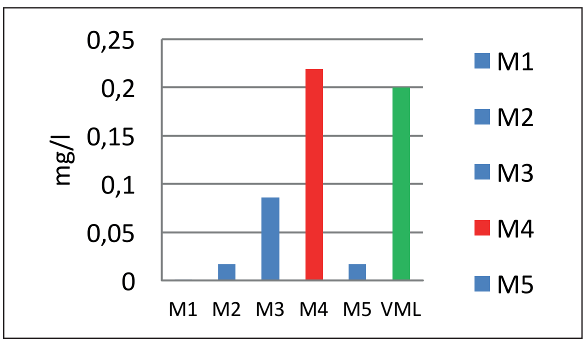

Figure 2. Fe concentration according to sampling points in September 2019

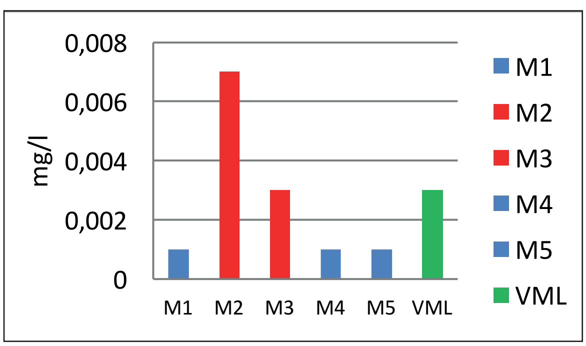

Figure 3. Cd concentration according to sampling points in September 2019

Pursuant to EU Directive 98/83, the we encountered Fe exceeding referring values at sampling point M4 with a concentration of 0.219 mg/L. Iron is essential element for good health because it transports oxygen in blood. The shortage of iron causes a disease called anemia and prolonged consumption of drinking water with high concentration of iron may lead to liver disease called as hemosiderosis (McDermid and Lönnerdal, 2012).

When cadmium enters the body, it is accumulated in the kidneys and can cause problems such as kidney dysfunction. Brittle bones, lung cancer and acute pneumonia are other health effects that arise from cadmium exposure (Robards and Worsfold, 1991).The Cd concentration in sampling point M3 is at the maximum permitted limit of 0.003 mg/L, whereas at sampling point M2 it exceeded the referring values at 0.007 mg/L.

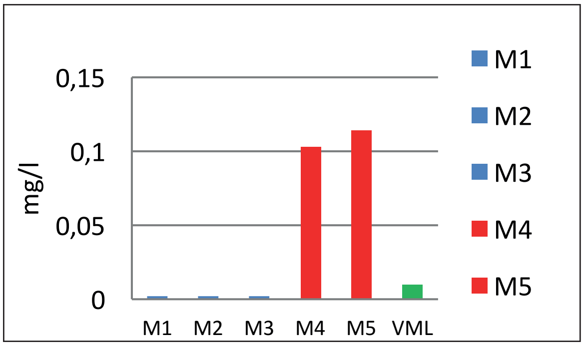

Figure 4. Pb concentration according to sampling points in September 2019

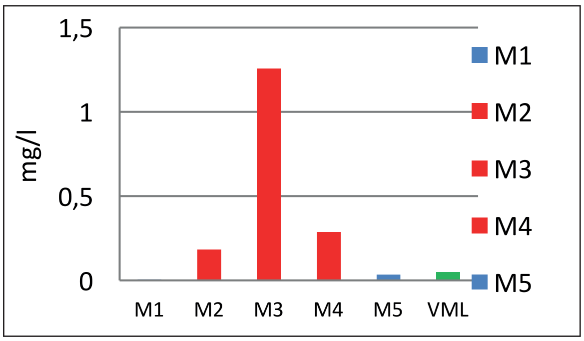

Figure 5. Mn concentration according to sampling points in September 2019

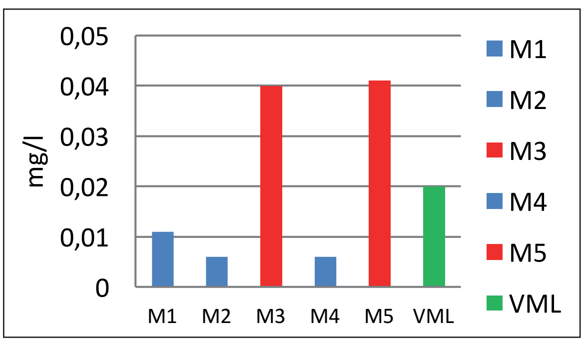

Figure 6. Ni concentration according to sample points in September 2019

We encountered Pb exceeding of referral values at sample points M4 and M5 at 0.103- 0.114 mg/L. Lead is toxic to the central and peripheral nervous system causing neurological and behavior effects. The consumption of lead in higher quantity may cause hearing loss, blood pressure and hypertension and eventually it may prove to be fatal (Terrence at al., 2007).

The table results present the significant exceeding, beyond referring values with Mn in three sampling points: M2 0.185 mg/L, at M3 1.254 mg/L and at M4 0.290 mg/L. The common presence of Mn in water, according to (ATSDR, 2015) determines the proper functioning of many cell enzymes, whereas the exceeding of referring values with Mn, causes negative health effects such as: muscle weakening, sensory problems, and inappropriate testosterone levels.

Nickel is relatively nontoxic if normal amounts are consumed through water and food. In high concentrations, Ni may cause changes to the respiratory tract - with the appearance of tumors, and skin changes. It also causes mutations to the p53e gene and in cooperation with oncogene V-H-Ras acts as a carcinogen (Rajkovic, 2003). In relation to Ni, we encountered exceeding of referring values at sample points M3 and M5 at the value of 0.040- 0.041 mg/L.

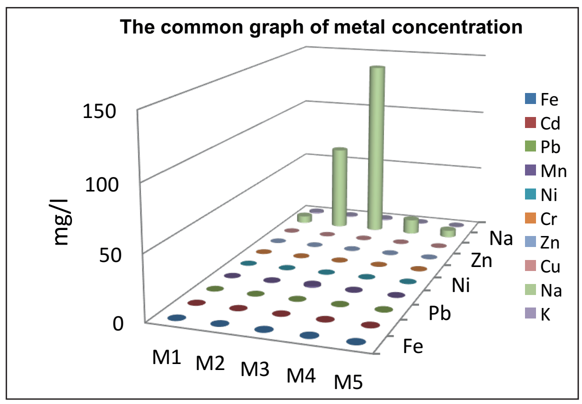

Figure 7. Concentration of metals according to sampling points in September 2019

There are no accurate data on the potential sources of heavy metal contaminators, because there are no hydrogeological studies, but it is thought that the soil composition is one of the causes for the presence of heavy metals, lack of sewerage system that divides wastewater and drinking water, use of fertilizers and other agricultural chemicals, but also the corrosion of water distribution pipes.

CONCLUSION

In general, groundwaters are considered safe sources for drinking purposes, due to the depth of their location and therefore they are considered bacteriologically clean. Therefore, our study object was related to the quality of the drinking water of wells in villages Dremjak, Talinoc i Muhaxherve, Softaj, Gërlicë and Varosh in Ferizaj Municipality. The underground waters in these villages, which were analyzed, are used for drinking and other personal needs of the villagers. They are not aware of the presence of some heavy metals exceeding the referring values such as: Mn, Pb, Ni, Cd and Fe, nor about their harming effects that may surface after a period of time, because it is known that metals have the ability to bio accumulate.

There are no accurate data on the causes of contamination with heavy metals of the water used for drinking by the residents of these villages, but it is suspected that it is the soil composition, sewerage system, agricultural chemicals and the corrosion of drinking water supply pipes. Therefore, caring for water, especially drinking water, should be a priority not only for the residents of these villages, but especially for the responsible institutions both at the local and central level. They (institutions) not only are obliged to notify the villagers on the current situation of their water quality, they drink, but to also undertake the required measures to remove the water contamination causes.

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