Available online at
http://journals.usamvcluj.ro/index.php/promediu

ProEnvironment

ProEnvironment 6 (2013) 465 - 471

Original Article

Monitoring of the Quality of the Drinking Water from the WTP Gilau, Obtained from the Surface Water in 2012

MOŞNEAG Silvia Claudia[1,2*], Violeta POPESCU[2], Călin NEAMŢU[1]

[1]*Somes Water Company, Water Analysis Laboratory of the WTP Gilău, 79 21 December 1989 St., 400604 Cluj-Napoca, Romania*
[2]*Technical University of Cluj-Napoca, Faculty of Materials and Environmental Engineering, 103-105 Muncii St.,400641 Cluj-Napoca, Romania*

Received 25 May 2013; received and revised form 23 June 2 013; accepted 3 August 2013
Available online 30 September 2013

Abstract

The scope of the present study is the evaluation of water quality of the surface water from the Tarniţa Lake, the Warm Someş Lake and the Gilău Lake and the drinking water resulted from the treatment station, based on a set of specific parameters as a first assessment of the implementation of the Directive 98/83/EC. It was made a monitoring of the main parameters analyzed from the three Lakes and the values were compared to the one obtained after water treatment, in the course of 2012. The results reveal that turbidity and total hardness are below the maximum contaminant level (MCL). The concentration of iron, sulfate, magnezium, calcium, nitrate, nitrite, and ammonium was also measured, showing that the water supplies for Gilau Water Treatment Plant contain small quantities of inorganic impurities. Microbiological analysis (total Coliforms, fecal Coliforms, fecal Enterococci, Clostridium perfringens) were also determined.

Keywords: drinking water, surface water, Tarniţa Lake, Warm Someş Lake, Gilău Lake.

1. Introduction

In Romania, water intended for human consumption is obtained from surface water, approximately 92% and groundwater resources. The existing systems of water supply cover only 65% of population consumption (97% for urban population). Water is present in air, soil and living things (in the body), is a renewable natural resource like air and light and is important for human existence. Drinking water should be free from any substances constituting a potential danger to human health, should be aesthetically acceptable and should not contain any microorganisms known to be pathogenic, capable of causing disease or any bacteria indicative of fecal pollution [3].

* Corresponding author.
Tel.: +40 264 401200; Fax: +40 264 592 055
e-mail: claudiamosneag@yahoo.com

Quality indicators are specific parameters for each type of water, in this case the surface one. Accepted values of quality indicators, which assess the degree of water pollution, are included in the Technical Standards for Protection of Waters (NTPA).

Cluj-Napoca city with an estimated population of about 350 000 inhabitants is supplied with water coming from the following reservoirs:

- Gilău Lake, which was formed by dam construction in 1972. It is located in the village Gilău, Cluj County, at an altitude of 422.25 m. The Gilău Mountains are in contact with peripheral hills, Small Someş (Someşul Mic) river downstream of the confluence of the rivers Warm Someş (Someşul Cald) and Cold Someş (Someşul Rece). It has a volume of 4.2 million cubic meters, an area of approximately 68 ha, about 23 m depth, and a length of 2 km […].

- Warm Someş Lake (LSC) is an artificial lake, located between the Gilău Lake (LGIL) and Tarniţa Lake (LT), the Gilău village, Cluj County, being fed by the waters of the Warm Someş Valley, has a volume of 7 million cubic meters, an area of 78 ha, 34 m depth and a length of 3.8 km [7, 8].
- Tarnța Lake is placed in Cluj County on the course of the Warm Someş River, upstream from the town of Gilău. It is a man-made lake, being a hydroelectric dam that provides hydroelectric power to the national power grid. It has a volume of 74 million cubic meters, the lake area is 220 ha, the depth 97 m and the length of 9.7 km […].

Water from Gilău Lake was used until 2002, when entered the operating Lake Warm Somes. Raw water was submitted to Gilau Treatment Plant trough a 1200 mm diameter pipe. As an alternative to both sources of water from the Warm Someş and Gilău lakes since 2009 it was used raw water comes from Tarniţa Lake. The quality of raw water from this lake is much higher compared with raw water from Gilău and Warm Someş Lakes. The raw water is transmitted to Gilău Treatment Plant from Tarniţa Lake through a 4.6 km pipeline with a capacity of 3 m^3/s.

Surface waters contain impurities in excess of ten times, and sometimes hundreds of times than drinking limits. The task of removing these impurities belongs to the treatment plant, which through various structures and installations carried out a chain of processes, in a continuous flow technology, which finally sent to the consumer drinking water with proper qualities. The efficiency of treatment plants is particularly appreciated taking into account the way it provides day by day, hour by hour treated water with higher quality parameters compared to the raw water quality [6]. The flow of the process includes the following stages: the capture of the raw water, the coagulation and flocculation reagents dosing (aluminum sulfate, calcium hydroxide and polyelectrolyte), decantation, filtration and disinfection.

Figure 1 shows the scheme of technological process consists of several elementary steps closely interrelated, each process being composed of other sub-technical processes.

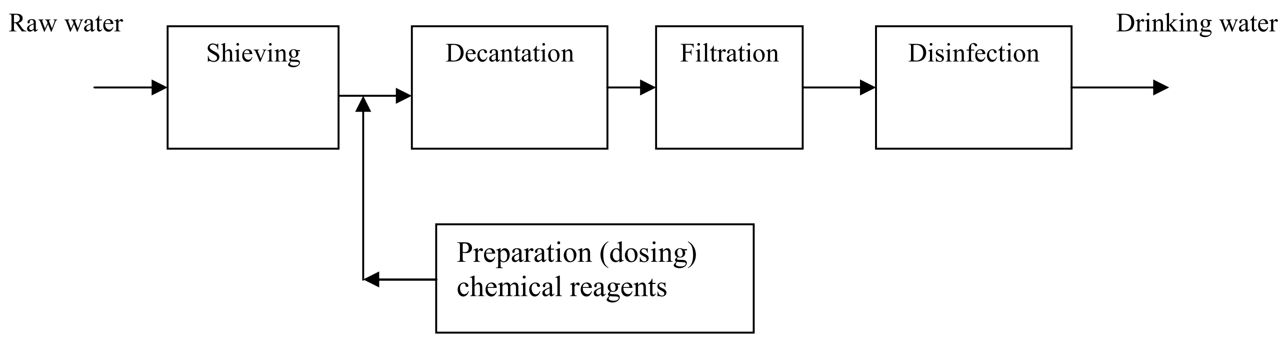


Figure 1. The scheme of water treatment technological process

Romania being a member of the European Union adopted the Directive 98/83/EC related to drinking water quality, which was implemented in Romania by Law 458/2002 republished in 2011. Drinking water must be free from microorganisms or substances which, in numbers or concentrations, constitute a potential danger to human health [18].

Provisions concerning the quality of drinking water established by the Directive allow Member States to adopt the monitoring of water quality to local conditions, in order not only to evaluate its safety for consumption, but also to detect any relative toxicological problems and to introduce the appropriate measures for the restoration and achievement of good drinking water quality. Drinking water quality is strongly influenced by the quality of the corresponding "parent"natural water from which drinking water derives [4].

2. Material and method

The collection of samples was carried out by the members of water analysis laboratory of the WTP Gilău from Someş Water Compan*y,* carefully following precise instructions and detailed protocols in order to avoid any contamination during sampling and transportation.

Samples were collected between January and December of 2012 from three lakes (Tarniţa

Lake, the Warm Someş Lake and the Gilău Lake) and frequently used household taps.

The turbidity was determined using a HACH 2100P turbidimeter, according to the European Standard EU ISO 7027 [19]. The pH measurements were carried out using a WTW multimeter Inolab 740 and determination was performed according to the International Standard ISO 10523/2008 [22]. Nitrates, nitrites and ammonium, were determined by using a LAMBDA BIO 40 UV-VIS spectrophotometer from PERKIN ELMER [16, 13, 14].

The volumetric titration method has been used for the following determinations: Chemical Oxygen Demand (COD) or permanganate index, chloride, the total hardness, calcium and magnesium [17, 15, 11, 12].

Analysis of metals were performed by a furnace AAS Analytik Jena Contraa 700, using a high-resolution continuum source, equipped with multi-lamp system [21].

For the determination of heavy metal samples were collected in polypropylene bottles thoroughly cleaned by soaking for a week in 10% nitric acid and then carefully and repeatedly rinsed with water (the conductivity of water measured with MicroMed 6 conductometer is 18.2 MΩ cm). The water sample is acidified with the addition of a few drops of 65% nitric acid supra pure until pH is 2.0.

3. Results and discussions

Physical and chemical parameter values determined during the study period for surface and drinking water, in order to ensure the quality of drinking water produced in the treatment plant from Gilău, Cluj–Napoca. Table 1 presents the statistical characteristics of all the examined physical and chemical parameters. In Table 2 are presented maximum and minimum values of Total Coliforms, Fecal Coliforms, Fecal enterococci and Clostridium Perfringens. The number of Total Fecal Coliforms and Fecal Enterococci is higher in the Gilău lake followed by Warm Someş Lake and then by Tarniţa Lake. Clostridium Perfringens was found in relatively small numbers in all three lakes.

Table 1. Physical and chemical parameters of raw water from Tarniţa Lake, Warm Someş Lake, and Gilău Lake

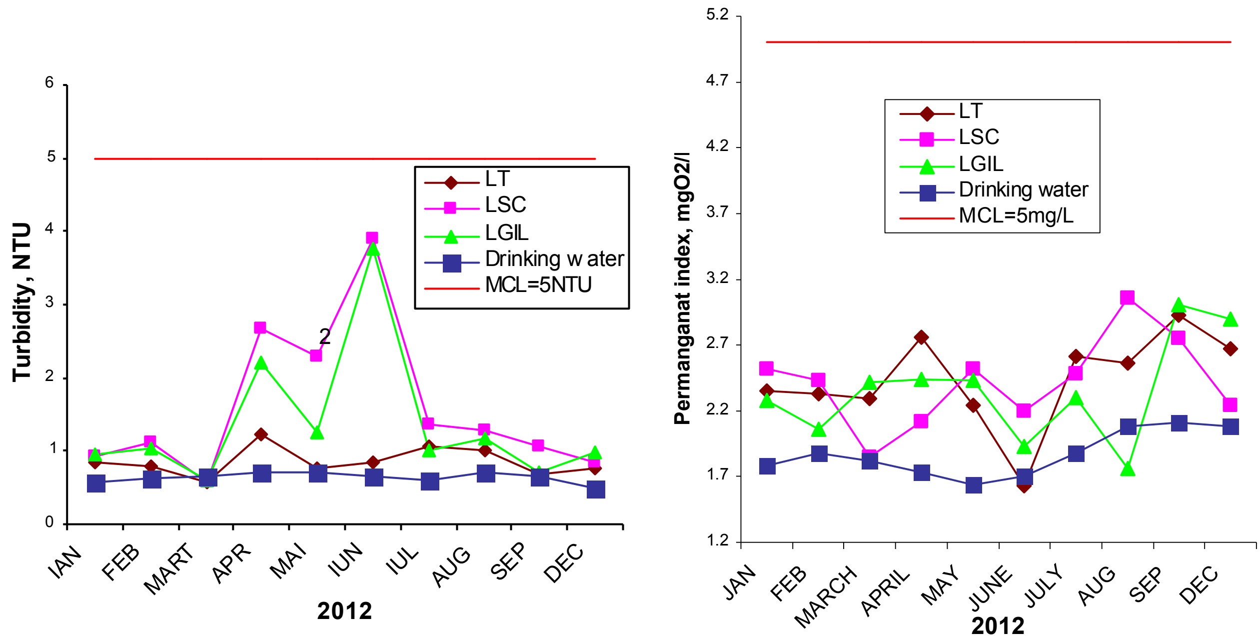
No. crt.	Parameter	Tarnita Lake		Warm Someş Lake		Gilău Lake	
		Min.	Max.	Min.	Max.	Min.	Max.
1	Total hardness, ^oG	2.05	2.83	2.16	4.32	2.15	3.08
2	Temperature, ^oC	1.4	14	1.8	19	2.9	16
3	Calcium, mg/L	11.03	13.22	10.83	17.43	11.65	14.82
4	Magnesium, mg/L	2.23	4.45	1.94	5.71	1.36	4.37
5	Iron, mg/L	0.01	0.06	0.02	0.10	0.02	0.12
6	Sulfate, mg/L	7.27	12.56	6.01	11.93	6.84	12.73

Table 2. Microbiological analysis of water from Tarnita Lake, Warm Somes Lake and Gilau Lake

No. crt.	Parameter	Tarniţa Lake		Warm Someş Lake		Gilău Lake	
		Min.	Max.	Min.	Max.	Min.	Max.
1	Total coliforms, nr./100mL	11	540	17	9200	330	16000
2	Fecal coliforms, nr./100mL	8	540	7	5400	22	9200
3	Fecal enterococci, nr./100mL	5	540	7	1800	22	1800
4	Clostridium perfringens	0	15	6	24	2	38

The raw water coming from the three lakes of surface water during 2012 was characterized by high turbidity (fig. 2a), water turbidity of treated water (drincking water from the fig. 2) is well below the maximum allowed by legislation (the maximum contaminant level, MCL=5 NTU).

Organic matter from reservoirs is dissolved or as a particulate form depending on the size and the degree of solubility. A proportion of 80 - 90% from dissolved organic matter is composed of carbohydrates, lipids and proteins. Figure 2b shows that the organic loading expressed by permanganate index (IP) was smaller than the maximum contaminant level (MCL = 5 mg O_2/L) both in the raw and treated water. Permanganate index constitutes an indicator of drinking water pollution by organic substances of natural origin or either anthropogenic (e.g. humic or fulvic acids).



(a) (b)

Figure 2. The variation of turbidity (a) and of permanganate index (b) during 2012.

The concentration of nutrients (nitrates and nitrites) was very low at all three lakes (fig. 3.) The increasing of nitrogen compound concentrations in lakes favor the development of excessive algae and protozoa [2].

The nitrate ion is the stable form of combined nitrogen for oxygenated systems.

Although chemically unreactive, it can be reduced by microbial action. The nitrite ion contains nitrogen in a relatively unstable oxidation state. Chemical and biological processes can further reduce nitrite to various compounds or oxidize it to nitrate [1].

The higher concentrations of chlorides in drinking water compared to the concentration from the water sources, is due to water disinfection with chlorine (fig. 4a).

Most treatment plants use chlorine worldwide for disinfection of treated water, but there are cases where ozone is used.

Chlorine oxidizes organic substances in water, resulting in hydrochloric acid and hypochlorous acid, which is 80 times more effective than hypochlorite ions (dissociated from a weak acid -hypochlorous acid) disinfection is more effective in acidic conditions.

The pH was mainly neutral for all lakes (fig. 4b), indicates the H^+ ion concentration being influenced by the total amount of CO_2 (free CO_2, H_2CO_3, HCO_3^-, and CO_3^{2-}).

The CO_2 generation under natural conditions leads to increased acidity, while consumption of CO_2 increases the alkalinity.

Most of the CO_2 from water comes from the atmosphere and the breathing of aquatic organisms.

CO_2 is required for the process of the photosynthesis of chemoautotrophic microorganisms and in small amounts of the heterotrophic bacteria [9].

Natural water sources (fig. 5) contain very low concentrations of lead.

Metal enter in the drinking water as it passes through the pipes, joints or lead-based brass and bronze parts (which can contain lead).

Lead can enter into the drinking water through corrosion of pipes, which is likely to happen when the water is slightly acidic (pH of drinking water in Cluj Napoca is between 6.98 to 7.24, slightly alkaline) [10].

Both long term and short-term exposure to lead through water cause serious health problems [5].

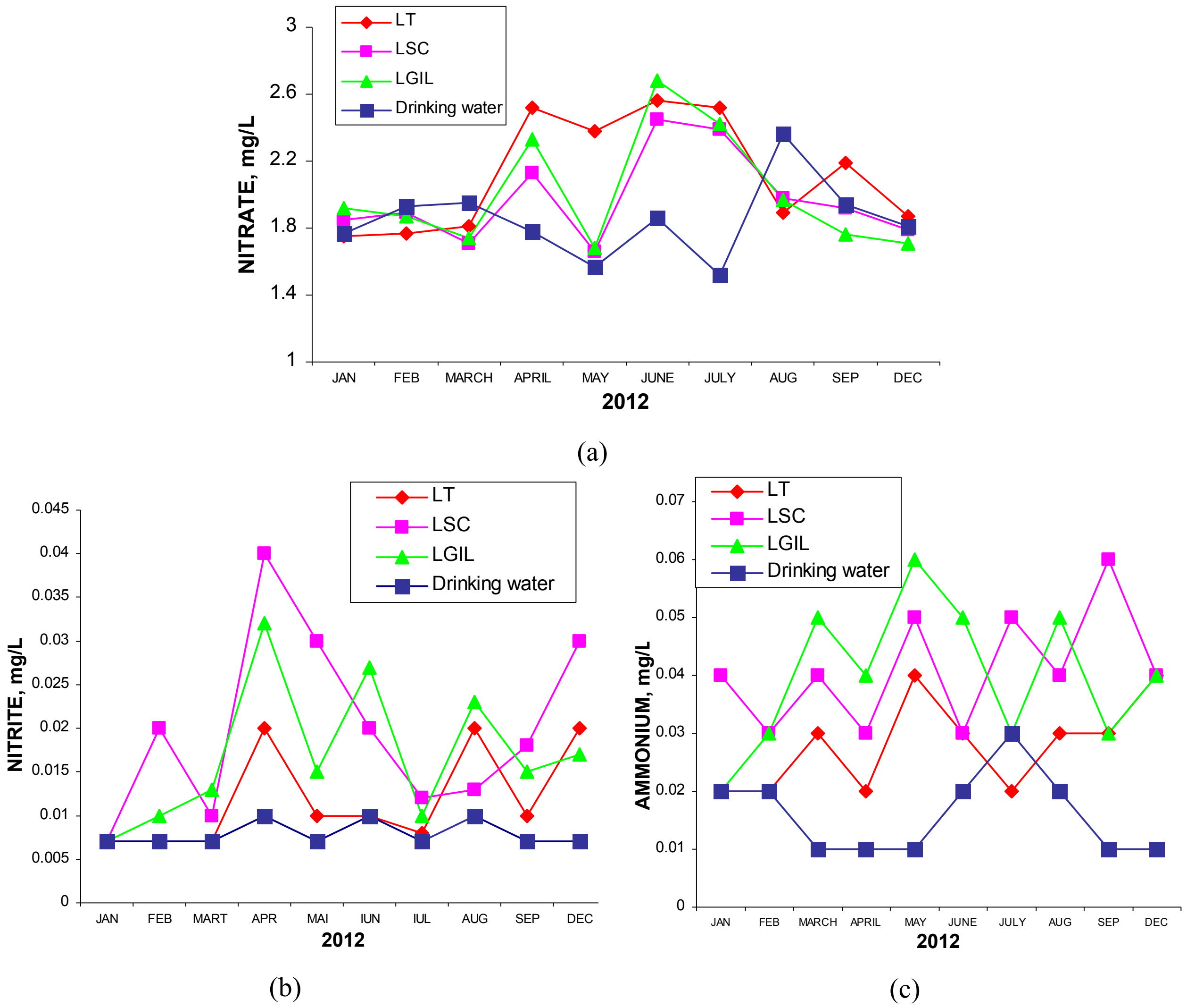


Figure 3. The variation of nitrate (a), nitrites (b) and ammonium concentration (c), during 2012

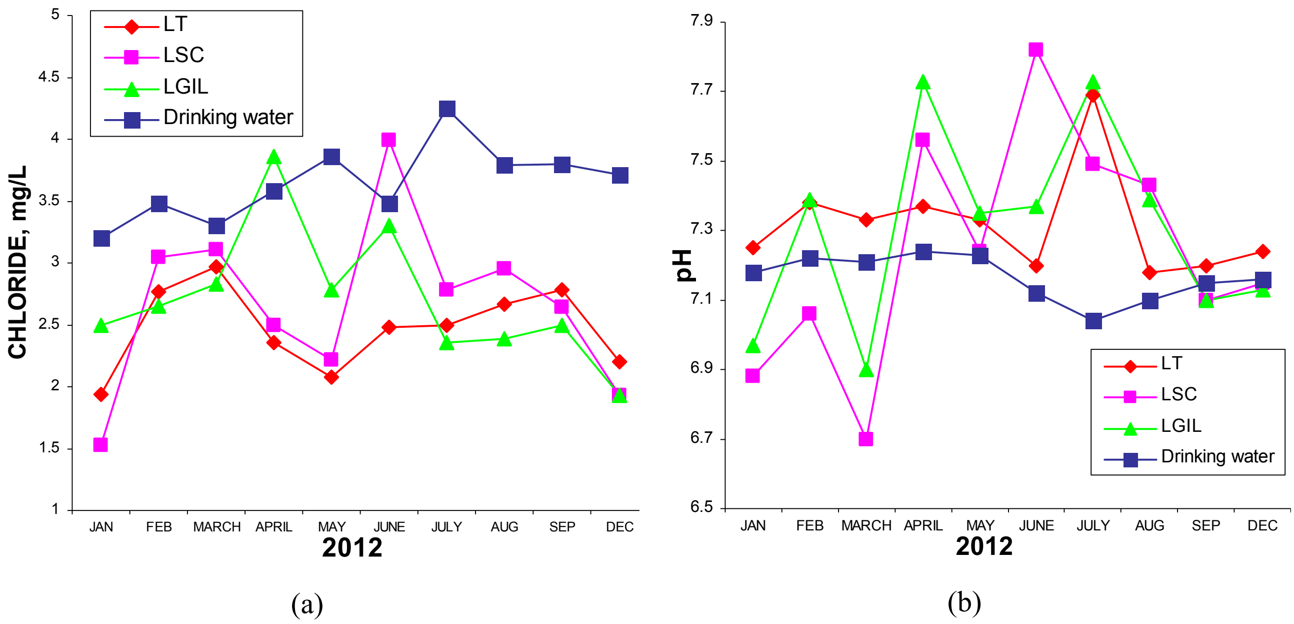


Figure 4. The variation of chloride concentration (a) and pH (b) during 2012

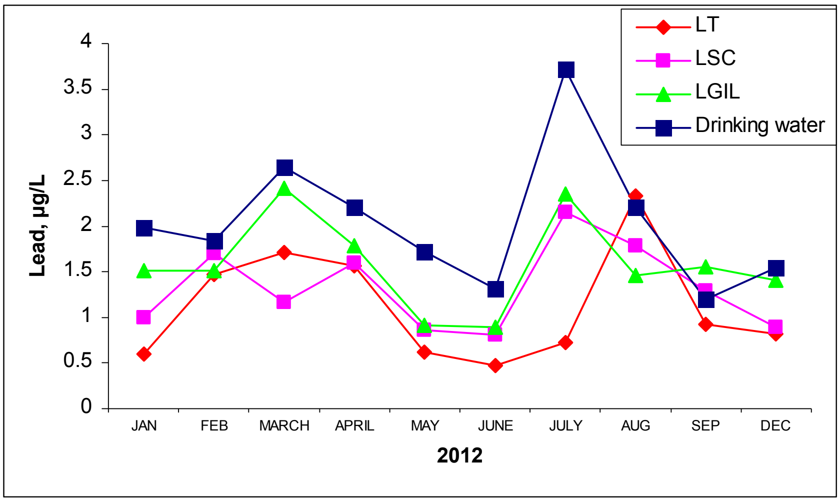


Figure 5. The variation of lead concentration during 2012

4. Conclusions

Based on experimental results of this study and compared with the rules in force, water from three lakes (Tarniţa, Warm Someş and Gilău) falls in terms of the indicators monitored in first class (A1), water quality compliant surface water and can be used for drinking [20].

The quality of raw water from Tarniţa Lake is far superior compared with surface water from Gilău and Warm Someş Lakes, which is reflected in the minimum costs in the treatment of raw water from the Gilău treatment plant.

In raw water sources there are some increases, especially in turbidity in some months, depending on the season.

The parametric values set monitored in the present study for drinking water is in accordance with legislation. The concentration of lead in drinking water is indirectly related to water treatment systems, being directly correlated to the transport system to the consumers.

Acknowledgement

This work was funded by the Doctoral School of the Faculty of Materials and Environment Engineering, Technical University of Cluj-Napoca and Someş Water Company. The authors would to espress their gratitude to their supervisior to Someş Water Company for his support and assistance in pursuing this research.

References

[1] Bilgehan N., A. Berktay, 2006, Groundwater contamination by nitrates in the city of Konya, (Turkey): A GIS perspective, Journal of Environmental Management 79, 30 – 37.

[2] Curticăpean M., M. Drăgan-Bularda, 2007, The enzymatic activity from thee sediment of the Gilău dam reservoir-Cluj County, Journal of Biochemical and Biophysical Methods, 69, 261–272.

[3] Damikouka I., A. Katsirib, C. Tzia, 2007, Application of HACCP principles in drinking water treatment, Desalination, 210, 138–145.

[4] Karavoltsos S., A. Sakellari, 2008, Evaluation of the quality of drinking water in regions of Greece, Desalination, 224, 317–329

[5] Moşneag S.C., R.S. Chira, 2011, Lead monitoring in the drinking water network from Cluj-Napoca, Romaqua, 2, 74.

[6] Rojanski V., T. Ognean, 1996, Paper operator stations and wastewater treatment, Technical Publishing House Bucharest.

[7] Şerban Gh., M. Alexe, 2006, GIS Applications in Reservoirs Management. Case Study, Someşul Cald, Geographia Technica Cluj-Napoca, 1, 181-186.

[8] Şerban Gh.**, M. Alexe,** 2008, *Differentiations in the sedimentation of the reservoirs basins from the Someşul Cald cascade system,* Studia Universitatis „Vasile Goldis”, Arad, 18, 313-323.

[9] Zarnea G., 1994, General microbiology treaty, vol. 5, Romanian Academy Publishing House Bucharest.

[10] Zietz B.P., J. Laß, R. Suchenwirth, H. Dunkelberg, 2010, Lead in Drinking Water as a Public Health hallenge, Environ Health Perspect, 118, 154-155.

[11] ***, 1984, International Standardization Organization, ISO 6058. Water quality. Determination of calcium. EDTA titrimetric method

[12] ***, 1984, International Standardization Organization, ISO 6059. Water quality. Determining the sum of calcium and magnesium. EDTA titrimetric method.

[13] ***, 1984, International Standardization Organization, ISO 7150-1. Water quality. Determination of ammonium. Part 1: Manual spectrometric method.

[14] ***, 1988, International Standardization Organization, ISO 7890-3. Water quality. Determination of nitrate. Part 3: Spectrometric method using sulfosalicylic acid.

[15] ***, 1989, International Standardization Organization, ISO 9297. Water quality. Determination of cloride. Silver nitrate titration with chromate indicator (Mohr's method).

[16] ***, 1993, European Standard, EN ISO 26777. Water quality. Determination of nitrite. Molecular absorption spectrometric method. Water quality. Determination of permanganate index.

[17] ***, 1995 ,European Standard, EN ISO 8467.

[18] ***, EC Directive, 1998, Directive 1998/83/EC of the European Parliament and of the Council of 3 November 1998, on the quality of water intended for human consumption. Official journal of the European Communities, L330/32, 5.12.1998, Brussels.

[19] ***, 1999, European Standard, EN ISO 7027. Water quality. Determination of turbidity.

[20] ***, 2002, Governmental Decision no. 100, Norms of qualities which must be fulfilled the surface waters used as drinking water, NTPA-013 - annex no.1, published in Romanian Official Monitor, part I, no. 130 from 19 february 2002.

[21] ***, 2003, European Standard, 2003, EN ISO 15586: 2003, Water quality. Determination of trace elements using atomic adsorption spectrometry with graphite furnace

[22] ***, 2008, International Standardization Organization, ISO 10523. Water quality. Determination of pH.