Applied Medical Informatics
Original Research Vol. 26, No. 1/2010, pp: 27-34

Monitoring of Water Source Gilău and its Affluent Someşul Rece during 2005-2009

Anca FARKAS[1,*], Dorin CIATARÂŞ[1], Brînduşa BOCOŞ[2], Ştefan I. ŢIGAN[3]

[1] Someş Water Company, 79 21 December 1989 Boulevard, 400604 Cluj-Napoca, Romania.
[2] National Public Health Institute - Regional Public Health Center of Cluj, 6-8 Pasteur Street, Cluj-Napoca, Romania
[3] "Iuliu Haţieganu" University of Medicine and Pharmacy, 6 Loius Pasteur, Cluj-Napoca, Romania
E-mails: farkasanca@yahoo.com; dorin.ciataras@casomes.ro; brindusa@ispcj.ro; stigan@umfcluj.ro.

* Author to whom correspondence should be addressed; Tel./Fax: 0040 264 371 818.

Received: 20 March 2010 /Accepted: 29 March / Published online: 30 March 2010

Abstract

The quality of drinking-water in Cluj-Napoca is controlled through a combination of measures: protection of water sources, control of treatment processes and management of the distribution and handling of the water. The first component, protection of water sources may be done only knowing as much of water quality and of the factors that threaten it. The present paper reveals the water source of Cluj, Gilău Lake and his affluent Someşul Rece River monitoring in a period of 5 years, between 2005 and 2009, their physical, chemical and microbiological parameters being monitored once a month, watching on the evolution of water quality. This surveillance offers a review of the safety and acceptability of drinking water supplies in Cluj County and contributes with several applicative aspects towards water quality supervision and evolution in time of the big dam reservoirs and their tributaries, which may be a major source of pollution downstream. Descriptive analyses, including the mean value, variability, trends, correlations and graphic displays were performed; SPSS and Epi-Info 2000 statistical software were used. Data analysis revealed that the good quality of Gilău Lake regarding physical and chemical parameters led to its framing in A1 quality category, except for ammonium and microbiological parameters, which allowed the framing in A2 quality category. Major averages in Someşul Rece than in Gilău Lake, up to 14 fold for faecal coliforms indicates the fact that the river worked out an important and constant pollution cause for Gilău water source during the period of time considered.

Keywords: Water quality; Water monitoring; Drinking water sources; Water pollution; Microbiological contamination.

Introduction

The basic human right consisting in access to safe drinking-water is seriously considered by international authorities as a component of effective policy for health protection.

Sustainable Society Index, integrating the most important aspects of quality of life, calculated in 2008, placed Romania on the last position among 37 countries considered, for the indicator „sufficient to drink". 43% of the population has no access to an improved water source and at least 20 liters of safe drinking water per person per day [1].

The quality of drinking-water in Cluj-Napoca is controlled through a combination of measures: protection of water sources, control of treatment processes and management of the distribution and handling of the water.

Prevention of microbial and chemical contamination of source water is the first barrier against drinking-water contamination of public health concern. Water resource management and potentially polluting human activity in the catchment will influence water quality downstream and in aquifers. This will impact on treatment steps required to ensure safe water, and preventive action may be preferable to upgrading treatment [2].

The present paper reveals the water source of Cluj, Gilău Lake and his affluent Someşul Rece River monitoring in a period of 5 years, between 2005 and 2009, their physical, chemical and microbiological parameters being monitored once a month, watching on the evolution of water quality. This surveillance offers a review of the safety and acceptability of drinking water supplies in Cluj County and contributes with several applicative aspects towards water quality supervision and evolution in time of the big dam reservoirs and their tributaries, which may be a major source of pollution downstream.

Gilău dam reservoir is located in the upper basin of Someşul Mic River, which has 3804 km^2 area and 167km length. In the upper basin of Someşul Mic River a dam reservoirs succession have been built, consisting in a water fall system of dams, the most important ones being Fântânele-Tarniţa-Someşul Cald-Gilău. Gilău dam building started in 1971 led to a reservoir with $4.2 \cdot 10^6$ m^3 capacities and 2.0km length. The dam reservoir serve several functions, mainly to guarantee drinking and industrial water since 1974, for Cluj-Napoca city and nearby towns and villages, energetic, flood and wave mitigation, recreation, fishing and trout nursery [3].

Until 2009 mainly Gilău and also Someşul Cald (since 2000) lakes were used to provide water to be treated in order to human consumption; from 2009 there are three alternative water sources, Tarniţa Lake started to feed the Water Treatment Plant, the headrace pipeline works being finished. The project brings, for the first time in Romania, an underwater pipe headrace at the bottom of Someşul Cald Lake.

Someşul Rece's basin covers an area of 276 km^2 and a high altitude, of 1220 m. Slope flow has an inclination ranging between 30 and 50 m/km and the multiannual average flow measured at the former hydroelectric plant Someşul Rece (before diverting water upstream) was 4.67 m^3/s (maximum recorded in April). Geological, it crosses the region consisting mainly in crystalline schist and eruptive rocks. The river has carved gorge into granite intrusions. River supply type is pluvio-nival, the climate zone being wet with abundant rainfall.

Material and Method

During the years 2005-2009 the water quality of Gilău Lake and his affluent Someşul Rece River has been monitored by monthly sampling and analysis of 52-67 specimens for every sampling point, from January 2005 to October 2009, for 20 physical, chemical and microbiological parameters: pH, temperature, turbidity, dissolved oxygen, COD, ammonia, nitrates, nitrites, phosphates, calcium, magnesium, total iron, chlorides, sulphates, copper, total chromium, lead, anionic surfactants, total coliforms and faecal coliforms.

The sampling procedure and sample transportation, preservation and preparation in order of analysis were performed according to specific standards [4-9]. The sampling point was set at the entrance of the water into the water treatment plant for Gilău Lake and at Someşul Rece upstream lake. The pH and temperature were measured in situ using a portable pH-meter [10]. Turbidity determination was performed using the laboratory turbidimeter [11]. Dissolved oxygen was quantified by titration method with sodium thiosulphate [12]. Chemical oxygen demand, represented by KMnO4 index was measured by titration [13]. Ammonia, nitrites, nitrates, phosphates and sulphates were determined by spectrometric measurement using a Lambda 40Bio Perkin Elmer spectrophotometer [14-18]. Water hardness measurement was performed by titration with complexone, calcium determination by titrimetric method and calcium hardness formula; magnesium was calculated using the formula of total hardness [19]. Chlorides were quantified by titrimetric method with silver nitrate and chromate indicator (Mohr's method) [20]. Iron, chromium, copper concentrations were determined using the AAS Analytic Jena [21- 23]. Anionic surfactants analysis was performed by measurement of the methylene blue index [24]. Total coliforms and faecal coliforms were detected and quantified via most probable numbers (MPN) technique: inoculation of 10, 1, 0.1 and 0.01 ml samples in Mac Conkey broth, incubated for 48

hours at 37°C (presumptive test), followed by total coliforms confirmation on Levine EMB Agar (24h at 37°C) and faecal coliforms confirmation on Brilla Broth (24h at 44°C) [25]. Sanitary water quality is assessed by the presence or absence of pathogenic microorganisms or their indicators. The wearing of a potential pathogen, the water could endanger health and even life. The key indicators of bacterial contamination of water and sediments are: total coliforms and faecal coliforms (the main indicator of water faecal contamination) and faecal enterococci. According to the isolated or associated presence of such bacteria, as well as their quantitative seasonal and annual variation, an assessment of the state sanitary and hygiene water and sediment may be done.

Descriptive analyses, including the mean value, variability, trends, correlations and graphic displays were performed; SPSS and Epi-Info 2000 statistical software were used [26].

Results

The statistical analysis has revealed the below results, and the water quality in the two lakes according to the regulations concerning the quality required of surface water intended for the abstraction of drinking water are shown in Table 1.

- pH registered a five years average value 7.27 for Gilău Lake, with a decreasing trend, maximum value 7.63 in November 2006 and minimum value 6.00 in January and April 2009, and an average of 7.03 with an increasing trend, maximum 8.60 in February 2007 and minimum 5.80 in November 2006 for Someşul Rece River.
- Temperature's average value in 2005-2009 was 8.60°C, maximum value 15.40°C in September 2005 and minimum 0.60°C in January 2009 for Gilău Lake, respectively average 8.61°C, with a maximum of 18.60°C in July 2006 and a minimum of 0.20°C in January 2006 for Someşul Rece River, with a slightly increasing trend for both waters.
- The average of turbidity in those 5 years was 5.05NTU in Gilău Lake, maximum recorded in March 2005, of 41.00NTU, and minimum 0.78NTU in November 2005. For Someşul Rece the 5-years average was 6.03NTU, maximum 86.80NTU, recorded in May 2006, and minimum 0.33NTU in February 2006. The tendency of both lakes' turbidity is decreasing.
- Dissolved oxygen in Gilău Lake had an average value of 10.59mg/l, maximum 12.60 mg/l in September 2009 and minimum 8.27 mg/l in August 2007 and for Someşul Rece average 10.86mg/l, maximum 13.80mg/l in January 2005 and minimum 7.70mg/l in July 2007. The trend of this parameter is increasing in both waters.
- COD in Gilău Lake averages 2.38mgO_2/l, maximum value registered being 5.34mgO_2/l in March 2006, minimum 1.30mgO_2/l in February 2009. In Someşul Rece River average value was 2.10mgO_2/l, maximum 9.32mgO_2/l in November 2007, and minimum 0.85mgO_2/l in January 2009. The trend is decreasing for both waters.
- Ammonia's average during 2005-2009 for both sampling sites was 0.05mg/l, also the lowest value, 0.00mg/l registered multiple times. In Gilău Lake maximum recorded in September 2008 was 0.39mg/l, and for Someşul Rece, in May 2006, was 0.60mg/l, both trends decreasing.
- For both lakes average for nitrites was 0.02mg/l, minimum 0.00mg/l, trends decreasing. In Gilău Lake: maximum 0.16mg/l in March 2005; for Someşul Rece maximum 0.06 in July-September 2005, July and November 2006.
- Nitrates' average in Gilău Lake amounted 2.08mg/l NO_3^-, maximum 3.65mg/l in April 2009, minimum 0.98mg/l in February 2007; for Someşul Rece average value was 3.00mg/l, maximum 6.01mg/l in June 2009 and minimum 1.24mg/l in August and in September 2008. Both trends are slightly increasing.
- Phosphates in Gilău averaged 1,71mg/l P_2O_5, maximum 4.14mg/l in January 2005, minimum 0.66mg/l in August 2008; Someşul Rece average 2.88mg/l, maximum 3.70mg/l in February 2005 and minimum 0.76mg/l in January 2006. Both trends are decreasing.
- Calcium registered an average of 12.29mg/l for Gilău, maximum 19.43mg/l in September 2008, minimum 5.06mg/l in February 2009; average 21.72mg/l for Someşul Rece, maximum 60.12mg/l in November 2008, minimum 9.99mg/l in October 2006. Both waters register a slightly increasing trend.
- Magnesium in Gilău Lake averaged 3.19mg/l, maximum value registered being 16.63mg/l in

March 2008, minimum 1.09mg/l in September 2008. In Someşul Rece River average value was 9.07mg/l, maximum 21.55mg/l in February 2006, and minimum 1.19mg/l in December 2007. The trend is decreasing for both waters.

Table 1. Position according to the regulations concerning the quality required of surface water intended for the abstraction of drinking water, maximal and minimal values, statistical comparison of means between parameters of Gilău and Someşul Rece Lakes

Parameter	Measuring unit	Values acc to A1*	Lake	Max	Min	Trend	Average	SD	p-value, test
pH	pH units	6.5-8.5	G	7.63	6.00	▼	7.27	0.301	0.000221 , KW
			SR	8.60	5.80	▲	7.03	0.549	
Temperature	°C	22	G	15.40	0.60	▲	8.60	3.841	0.888504 , KW
			SR	18.60	0.20	▲	8.61	5.386	
Turbidity	NTU		G	41.00	0.78	▼	4.86	7.621	0.321013 , KW
			SR	86.80	0.33	▼	6.03	11.708	
Dissolved oxygen	mg/L		G	12.60	8.27	▲	10.63	1.103	0.433647 , KW
			SR	13.80	7.70	▲	10.86	1.480	
COD	mg O_2 /L		G	3.42	1.30	▼	2.38	0.141	0.020129 , T
			SR	9.32	0.85	▼	2.10	1.119	
Ammonia	mg/L	1 (A2)	G	0.39	0.00	▼	0.05	0.005	0.400275 , KW
			SR	0.60	0.00	▼	0.05	0.007	
Nitrites	mg/L		G	0.16	0.00	▼	0.02	0.027	0.560680 , KW
			SR	0.06	0.00	▼	0.02	0.017	
Nitrates	mg/L	25	G	3.65	0.98	▲	2.08	0.629	0.000083 , KW
			SR	6.01	1.24	▲	3.00	1.321	
Phosphates	mg/L	0.40	G	4.14	0.66	▼	1.71	0.647	0.000493 , A
			SR	3.70	0.76	▼	2.08	0.601	
Calcium	mg/L		G	19.43	5.06	▲	12.29	1.708	0.0000001 , KW
			SR	60.12	9.99	▲	21.72	7.749	
Magnesium	mg/L		G	16.63	1.09	▼	3.19	2.113	0.0000001 , KW
			SR	21.55	1.19	▼	9.07	4.141	
Total iron	mg/L	0.1	G	2.00	0.01	▼	0.09	0.256	0.0000001 , KW
			SR	0.40	0.01	▲	0.11	0.103	
Chlorides	µg/L	200	G	4.86	0.68	▼	2.95	0.921	0.0000001 , KW
			SR	11.11	0.76	▼	4.94	1.884	
Sulphates	mg/L	150 (250**)	G	15.33	4.24	▼	9.84	2.627	0.000007 , KW
			SR	28.62	5.39	▼	14.84	6.175	
Copper	µg/L	0.02	G	134.70	0.00	▲	4.32	17.387	0.008874 , KW
			SR	402.90	0.06	▲	10.68	54.995	
Total chromium	µg/L	0.05**	G	2.36	0.01	▲	0.71	0.549	0.008557 , KW
			SR	203.70	0.00	▼	5.02	28.115	
Lead	µg/L	0.05**	G	8.47	0.08	▲	1.33	1.299	0.012572 , KW
			SR	1167.00	0.00	▼	25.08	164.794	
Total coliforms	nr./ 100ml	5000 (A2)	G	16090	4	▼	1059.29	2224.742	0.0000001 , KW
			SR	54000	90	▲	7931.50	10477.759	
Faecal coliforms	nr./ 100ml	2000 (A2)	G	3500	0	▼	288.79	543.249	0.0000001 , KW
			SR	54000	70	▲	4075.37	7983.430	

*-recommended values for quality category A1; **-mandatory values for quality category A1; ▲-increasing trend; ▼-decreasing trend; SD-standard deviation; KW-Kruskal-Wallis test; A-ANOVA test, T-Student test.

- Although iron's averages during 2005-2009 had similar values (0.09mg/l in Gilău and 0.11 in Someşul Rece), there were a different evolutions: in Gilău a peak was registered in 2006, with the maximum value 2.00mg/l in October 2006, a minimum of 0.01mg/l registered four times during those years and a decreasing trend is clear from data analysis; in Someşul Rece related values were registered: maximum 0.40mg/l in March 2008, and minimum 0.01mg/l two times, in July 2005 and 2007, and an increasing trend.
- Chlorides in Gilău Lake averaged 2.95µg/l, maximum value registered being 4.86µg/l in May 2006, minimum 0.68µg/l in November 2006. In Someşul Rece River average value was 4.94µg/l, maximum 11.11µg/l in May 2006, and minimum 0.76µg/l in January 2006. The trend is decreasing for both waters.

- Sulphates' average in Gilău Lake amounted 9.84mg/l, maximum 15.33mg/l in August 2006, minimum 4.24mg/l in February 2009; for Someşul Rece average value was 14.84mg/l, maximum 28.62mg/l in April 2006 and minimum 5.39mg/l in August and in September 2007. Both trends are decreasing, drastically for Someşul Rece.
- Copper in Gilău Lake had an average of 4,32µg/l, maximum being 134.70µg/l in September 2008, minimum 0.00µg/l in January 2006; in Someşul Rece average value was 10.68µg/l, maximum 402.90µg/l in September 2008, and minimum 0.06 in January 2006. In 2009 copper concentration in both waters receded, annual averages being 1.49µg/l, respectively 4.56µg/l. Although both trends are increasing, due to a peak of copper content in 2008 which appears to be a consequence of emptying the two dam reservoirs upstream (Someşul Cald and Tarniţa Lakes) due to the headrace of a new pipeline, but also in Agârbiciu River, an affluent Someşul Cald a similar peak of copper concentration had been registered in September 2008.
- Total chromium registered in those five years an average of 0.71µg/l, maximum 2.36µg/l in May 2006 and minimum 0.01µg/l in January 2006 in Gilău water source, trend slightly increasing, and an average of 5.02µg/l, maximum 203.70µg/l in May 2006, and minimum 0.00µg/l in October 2008 for its affluent, trend decreasing. A similar situation as in copper and iron concentrations case appears, this maximal value being an exception, all other results recorded being situated between 0.20 and 3.00µg/l chromium. High chromium concentrations were documented in May 2005 also for upstream lakes, and for Agârbiciu River it was enormous and untypical (683.00µg/l).
- Lead in Gilău averages 1,33µg/l, maximum 8.47µg/l in June 2008, minimum 0.08µg/l in April 2006, trend slightly increasing; Someşul Rece averages 25.08µg/l, maximum 1167.00µg/l in October 2005 and minimum 0.00µg/l in January 2006 repeated in March 2007, trend drastically decreasing due to the unusually maximum value reached in 2005.
- Anionic surfactants registered 0.00 values during the past five years in all determinations.

Total and faecal coliforms' evolution in those two dam reservoirs during 2005 and 2009 is ilustrated in Figure 1.

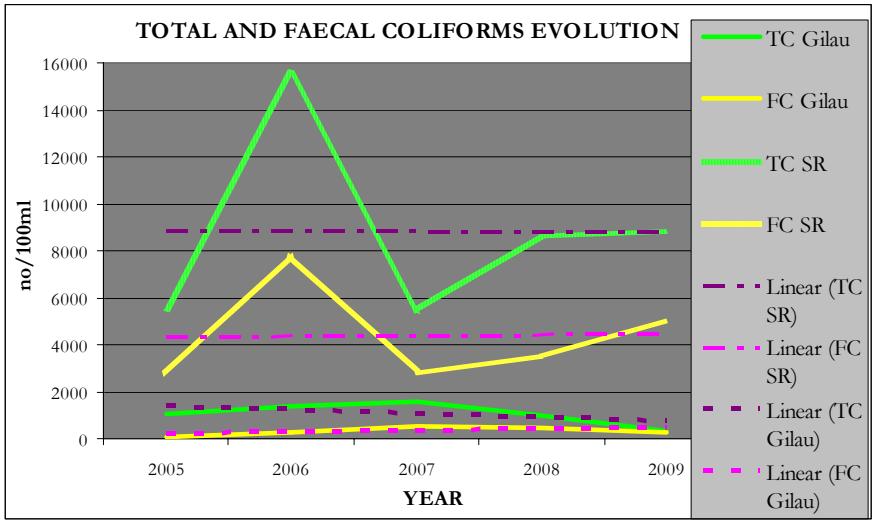

Figure 1. Total and faecal coliforms evolution in Gilău Lake and Someşul Rece River

- Total Coliforms registered a five-year average value of 1059.29/100ml sample for Gilău Lake, with a decreasing trend, maximum value 16090/100ml in August 2005 and minimum value of 4/100ml in October 2009, and average 8222.55/100ml with a mild increasing trend, a maximum of 54000/100ml registered two times, in July 2006 and July 2009, and a minimum of 90/100ml in December 2008 for its affluent.
- Faecal Coliforms developed a decreasing tendency in Gilău and a slightly increasing trend in Someşul Rece, values being for Gilău Lake: average 288.79/100ml, maximum 3500/100ml in August 2007 and minimum 0/100ml in October 2005, respectively for Someşul Rece River:

average 4072.39/100ml, maximum 54000/100ml in July 2006 and 70/100ml in December 2008.

The p-value <0.05 indicates significant differences between the averages of a certain parameter in the two waters. The majority of parameters considered revealed such significant differences, except for temperature, turbidity, dissolved oxygen, ammonia and nitrites, as shown in Table 2.

Table 2. Significant common correlation between Gilău and Someşul Rece Lakes parameters

Parameter pairs	Correlation coefficient	
	Gilău	SR
pH and nitrates	R_G = -0.3122	R_{SR} = -0.3094
Temperature and dissolved oxygen	R_G = -0.3632	R_{SR} = -0.6288
Temperature and faecal coliforms	R_G = 0.3188	R_{SR} = 0.4094
Turbidity and ammonia	R_G = 0.5660	R_{SR} = 0.9055
Turbidity and nitrites	R_G = 0.8527	R_{SR} = 0.3574
Turbidity and total coliforms	R_G = 0.2835	R_{SR} = 0.2646
Dissolved oxygen and faecal coliforms	R_G = -0.3334	R_{SR} = -0.3229
COD and nitrites	R_G = 0.2605	R_{SR} = 0.5012
Ammonium and nitrites	R_G = 0.7787	R_{SR} = 0.4663
Phosphates and sulphate ions	R_G = 0.3974	R_{SR} = 0.3317
Calcium and lead	R_G = 0.3340	R_{SR} = 0.2642
Chloride ions and sulphate ions	R_G = 0.2626	R_{SR} = 0.2939
Chloride ions and chromium (Cr total)	R_G = -0.2855	R_{SR} = 0.4570
Total coliform bacteria and faecal coliforms	R_G = 0.3558	R_{SR} = 0.7230

R_G =Pearson correlation coefficient between the pairs of water parameters in Gilău Lake;
R_{SR}= Pearson correlation coefficient between the pairs of parameters in Someşul Rece Lake

All parameter-pairs which have been common correlated have evolved in the same sense, except for a particular situation: chloride ions and total chromium registered a negative correlation in Gilău Lake and a positive one in Someşul Rece River, both weak (Table 2).

Significant correlations for pairs of parameters in both waters have been demonstrated as follows:

- Very strong between turbidity and ammonia in Someşul Rece (0.9055) and moderate in Gilău (0.5660);
- Very strong between turbidity and nitrites in Gilău (0.8527), while weak in Someşul Rece (0.3574);
- Very strong between ammonium and nitrites in Gilău (0.7787) and weak in Someşul Rece (0.4663);
- Moderate between COD and nitrites in Someşul Rece (0.5012) while weak in Gilău (0.2605);
- Moderate between total coliforms and faecal coliforms in Someşul Rece (0.7230), while weak in Gilău Lake (0.3558);
- Weak between all the other parameter pairs which have been mentioned in Table 2.

Discussion

According to local [27-29] and European [30] regulations, all the parameters allow Gilău Lake's water to be situated in A1 quality category, except for ammonia, total coliforms and faecal coliforms, whose values allow the classification in A2 quality category. From 2009 the new water source Tarniţa started to feed the water treatment plant, given to its higher quality. All the physical and chemical parameters allowed Tarniţa to be situated in A1 quality category. Total and faecal coliforms are still present in high amount for A1 quality category, but the decreasing trend for both parameters are indicating the improving of water quality [31].

Large variations (tenfold or more) for microbiological parameters within a lake are not unusual, given the rate at which bacteria multiply and die, but in the river the peaks may be done to animal and human feces discharge. Faecal coliforms group (precisely *E. coli*) indicates a recent contamination event. This representing one of the most severe anthropic effects, high bacteria levels also lead to low dissolved oxygen levels that make sustainability hard for aquatic species.

As it can be seen in figure 1, developing a decreasing trend in Gilău Lake, microbiological parameters confirm the improvement of water quality, maybe as a result of „Pollution Prevention Plan" initiated in 2003, regarding water sources protection [32-34].

After monitoring the above described parameters in order to ensure the drinking water safety, the next step is improving the assessment and management of drinking water safety by moving away from using monitoring simply as a tool to verify the safety towards using the results as a basis for risk management actions [35].

Conclusions

This study fulfills the need of using the monitoring parameters for ensuring the drinking water safety as a response to the increasing level of public and professional concern about water quality.

Once identified the main pollutants of Gilău Lake (microbial load), the solution is minimizing the possible contamination sources as grazing animals and diverting sewage overflows and discharge flows by establishing a protective strategy in the catchment.

- Concerning the quality required of surface water intended for the abstraction of drinking, the good quality of Gilău Lake led to its framing in category A1 for pH, temperature, turbidity, dissolved oxygen, COD, nitrites, nitrates, phosphates, calcium, magnesium, total iron, chlorides, sulphates, copper, chromium, lead, anionic surfactants. Not so well results were registered for microbiological parameters (total and faecal coliforms) and ammonium, the framing for those three parameters being A2 quality category.
- Significant differences between the parameters' values in the two waters emerged from the statistical analysis.
- Major averages in Someşul Rece than in Gilău Lake, up to 14 fold for faecal coliforms indicates the fact that Someşul Rece worked out an important and constant pollution cause for Gilău source during the period of time considered.
- The residence time of approximately 2 weeks in river channels gives Someşul Rece River the ability of rapid renewal, while much longer residence time of water in lakes and reservoirs (approximately 10 years) seriously affects the water quality in Gilău Lake, especially for drinking purposes.

References

1. Popovici C, Veraart R, van de Kerk G, Romania, on its way to a sustainable society, Uitgeverij De Vijver, The Netherlands, 2008.
2. World Health Organization, Guidelines for drinking-water quality: Vol. 1, Recommendations. 3rd ed., Geneva, 2006.
3. Şerban G, Reservoir dams from the superior basin of Someşul Mic. Hydrogeographic study, Universitary Press of Cluj-Napoca, ISBN 978-973-610594-4 (in Romanian), 2007.
4. SR ISO 5667-2/1991 Water quality - Sampling - Part 2: Guidance on of sampling techniques, Romanian Standards Institute.
5. SR EN ISO 5667-3/2002 Water quality - Sampling - Part 3: Guidance on the preservation and handling of samples, Romanian Standards Association.
6. SR ISO 5667-4/2000 Water quality - Sampling - Part 4: Guidance on sampling from lakes, natural and man made, Romanian Standards Institute.
7. SR EN ISO 3696/2002 - Water for analytical laboratory use - Specification and test methods, Romanian Standards Association.
8. SR EN ISO 19458/2007 Water quality – Sampling for microbiological analysis, Romanian Standards Association.
9. SR EN ISO 6887-1/2002 Microbiology of food and animal feeding stuffs - Preparation of test samples, initial suspensions and decimal solutions for microbiological examination - Part1: General rules for the preparation of the initial suspension and decimal dilutions, Romanian Standards Association.
10. SR ISO 10523/1997 Water quality - Determination of pH and temperature, Romanian Standards Institute.

11. SR EN ISO 7027/2001 Water quality - Determination of turbidity, Romanian Standards Association.
12. SR ISO 6060/1996 Water quality - Determination of chemical oxygen demand, Romanian Standards Institute.
13. SR EN ISO 8467/2001 Water quality - Determination of permanganate index, Romanian Standards Association.
14. SR EN ISO 7150-1/2001 Water quality - Determination of ammonium - Part 1: Manual spectrometric method, Romanian Standards Association.
15. SR EN ISO 26777, ISO 6777/2002 Water quality. Physical, chemical and biochemical methods. Determination of nitrite: molecular absorption spectrometric method, Romanian Standards Association.
16. SR ISO 7890-1/1998 Water quality - determination of nitrate - Part 1: 2,6-Dimethylphenol spectrometric method, Romanian Standards Association.
17. STAS 3265/1986 Water quality - Determination of phosphates, Romanian Standards Institute.
18. STAS 3069/1987 Water quality - Determination of sulphates, Romanian Standards Institute.
19. SR EN ISO 6059/1984 Water quality -Determination of the sum of calcium and magnesium -EDTA titrimetric method
20. SR ISO 9297/2001 Water quality - Determination of chloride, Romanian Standards Association.
21. SR 13315:1996/C91/2008 Water quality - Determination of iron content. Atomic absorption spectrometric methods.
22. SR ISO 9174/1998 Water quality - Determination of chromium - Atomic absorption spectrometric methods, Romanian Standards Association.
23. SR ISO 8288/1986 Water quality - Determination of cobalt, nickel, copper, zinc, cadmium and lead - Flame atomic absorption spectrometric methods, Romanian Standards Institute.
24. ISO 7875-1:1996 Water quality - Determination of surfactants - Part 1: Determination of anionic surfactants by measurement of the methylene blue index (MBAS).
25. SR EN ISO 9308-2/1990 Water quality - Detection and enumeration of coliform organisms, thermotolerant coliform organisms and presumptive Escherichia coli - Part 2: Multiple tube (most probable number) method, Romanian Standards Association.
26. Ţigan S, Achimaş A, Drugan T,Course in medical informatics and statistics, SRIMA Press, Cluj-Napoca (in Romanian), 2007.
27. H.G. no 100/2002 Romanian Government Decision for the approval of quality requirements of surface water intended for the abstraction of drinking water [NTPA-013] and regarding the measurement methods and the frequency of sampling and analysis of samples from surface water serving as drinking water sources [NTPA-014] (updated), (in Romanian).
28. H.G. no 567/2006 Romanian Government Decision regarding the changes of HG 100/2002 for the approval of quality requirements of surface water intended for the abstraction of drinking water in Romania (in Romanian).
29. H.G. no 662/2005 Romanian Government Decision regarding the changes of HG 100/2002 for the approval of quality requirements of surface water intended for the abstraction of drinking water in Romania, (in Romanian).
30. 75/440/EEC Council Directive of 16 June 1975 Drinking Water Directive concerning the quality required of surface water intended for the abstraction of drinking water in the Member States, Official Journal L194.
31. Farkas A, Bocoş B, Ţigan Ş, Ciatarâş D, Drăgan-Bularda M, Carpa R, Surveillance of two dam reservoirs serving as drinking water sources in Cluj, Romania, IWA Balkans Conference of Young Water Professionals, Water Science and Technology, submited.
32. Someş Water Company, Pollution Preventing Plan in Tarniţa-Gilău Basin, Cluj-Napoca, Romania (in Romanian), 2003.
33. UNESCO/WHO/UNEP, Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring - Second Edition, E&FN Spon, 1996.
34. Ford T, Colwell R, A global decline in microbiological safety of water: A call for action, American Academy of Microbiology, Washington DC, 1995.
35. World Health Organization and Organization for Economic Co-operation and Development, Assessing microbial safety of drinking water, IWA Publishing, Cornwall, UK, 2003.