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# ASSESSMENT OF CHINTENI RIVULET (ROMANIA) WATER QUALITY UNDER THE IMPACT OF THE ANTHROPOGENIC FACTOR

**Ildiko Melinda MARTONOȘ[1], Maria PETRUȘ[1], Cristina ROȘU[1]***

*[1]Babeș-Bolyai University, Faculty of Environmental Science and Engineering, 30 Fântânele Street, Cluj-Napoca, România*
**Corresponding author: cristina.rosu@ubbcluj.ro*

**ABSTRACT.** In the environmental issue context, surface water quality has an important place. Implementing measures truly effective, sustainable in prevention and control of water pollution, is urgently needed, because degradation of their quality affects the quality of human life. This paper presents the study and research on the assessment of quality status of Chinteni Rivulet (Cluj County) under the pressure created by possible anthropogenic pollution sources. Water sampling was conducted in the period November 2015 - May 2016, in five representative points. We measured the physico-chemical parameters (pH, temperature, total dissolved solids, electrical conductivity, redox potential, chlorides, sulfates, nitrates, nitrites, ammonium, filterable residue dried at 105 °C, suspended matter and total chromium) and oxygen regime parameters (dissolved oxygen, chemical oxygen demand). Results show that there were registered high contents of nitrates, nitrites, sulfates, oxidisable organic substances, chlorides and total chromium, downstream from the anthropogenic sources of pollution. The anthropogenic sources of pollution put pressure on the water quality of Chinteni rivulet, and the trend is of the increase of pollutants and is directly proportional to the population density and intensification of economic activities

**Key words:** *Chinteni rivulet, contamination, water quality, pollutants, nitrates*

## INTRODUCTION

The purpose of this study is to establish the surface water quality from Chinteni Rivulet and to identify the pressure created by possible sources of anthropogenic pollution in the area (economic agents and households not included in the sewerage network, which evacuates untreated waters into natural receptors). In the environmental issue context, surface water quality also has an important place. Implementing measures truly effective, sustainable in prevention and control of water pollution, is urgently needed, because degradation of their quality affects the quality of human life (Xin et al., 2015).

We chose the Chinteni rivulet as a study area, because the number of studies conducted on this watercourse is low, therefore the existing data on the physico-chemical composition of water is vaguely outlined and there is a possibility that the rivulet to transport the pollutants to the Someşul Mic river through the discharge of waste water or other wastes from domestic or economic activities, because the sewerage network does not exist across the entire area through which this Chinteni rivulet passes. After the discharge of the waste waters into the surface waters, there take place a series of physical, chemical and biological processes (Cojocaru, 2012).

Over the past 15 years, a number of substantial reforms have been developed, which correspond to the overall objective of efficient and sustainable water resource management. The European Union and other regions have recognized the issue of degradation of ecosystems and water quality and have established innovative reforms through regulatory frameworks to restructure the water management approach (Cross and Latorre, 2015).

For the evaluation of the Chinteni rivulet quality was calculated the Water Quality Index (WQI), the evaluation using integrated indices, can be a complex process, including a semnificative number of parameters wich contribute with diferent pressure on surface water quality (Teodorof et al., 2016; Bharti and Katyal, 2011).

The Water Quality Index (WQI) provides complex scientific information and embraces a series of data in a single number, with a simple logical connotation ie whether the water is in the grade of the proposed use (Tyagi et al., 2013).

Several methods of determining WQI are known in the literature, such as the National Sanitation Foundation Water Quality Index (NSFWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) , Oregon Water Quality Index (OWQI), Weighted Arithmetic Water Quality Index Method an others.

In this study we used the Canadian method for calculating the water quality index of the Chinteni rivulet, whose empirical equation is below (ecuation 1).

$$WQI = 100 - \frac{\sqrt{F1^2 + F2^2 + F3^2}}{1.732} \qquad (1)$$

where **WQI** = is a number between 0 and 100 (for significant pollution levels the value may exceed 100);

F1 (Scope) = number of variables, whose objectives are not met.

F1= [no. of failed variables /total no. of variables]*100

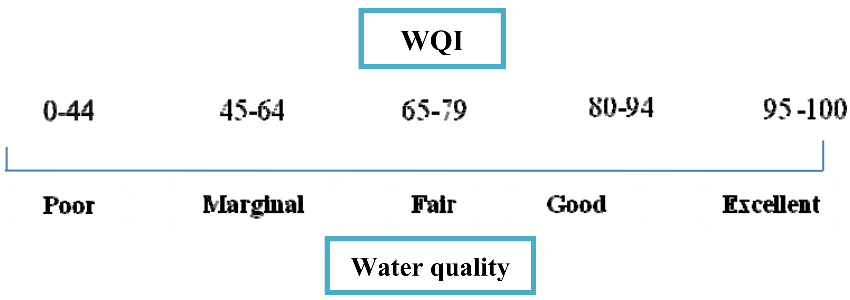
F2 (Frequency)= number of times by which the objectives are not met, in relation to

MCL (Class II, acording 161/2006 Order)

F2 = [no. of failed tests/total no. of tests]*100

F3 (Amplitude) = amount by which the objectives are not met (20/50/80) (CCME, 2001).

This Canadian method has been developed to evaluate surface water for protection of aquatic life in accordance to specific guidelines and can be used in various countries with slight modification (Khan et al., 2005; Kankal et al., 2012; Lumb et al., 2006). The obtained results will be in the standard values of the method which are presented as follows (CCME, 2001):



## EXPERIMENTAL

The water samples were collected from the Chinteni rivulet monthly, between November 2015 and May 2016, to observe the spatial and time evolution of the main water quality parameters. The sampling points were chosen as representative for the area (upstream and downstream of possible sources of pollution) as shown in figure 1. PC0, PC1, PC2, PC3 – are the sampling points along the rivulet and G1 discharge canal of wastewater in Chinteni rivulet.

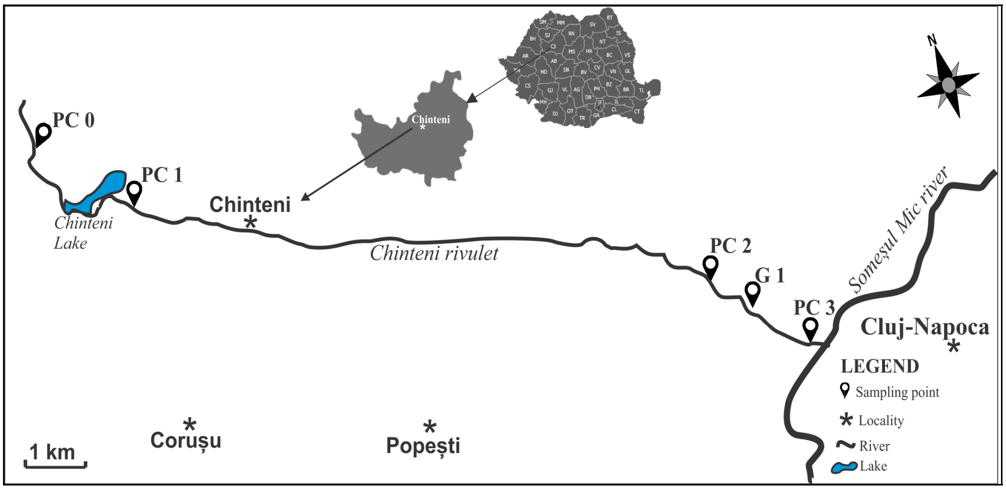



**Fig. 1.** *Map of the sampling points*

For the analysed parameters were used: *potentiometric methods*: pH, total dissolved solids, electrical conductivity, redox potential with the use of a WTW inoLab 720 series Multiparameter; *volumetric methods*: dissolved oxygen (DO), chemical oxygen demand (COD-Cr and COD-Mn), chlorides, ammonium; *spectrometry methods*: nitrates, nitrites, sulfates, total chromium with UV-VIS Aquamate Molecular Spectrophotometer (TermoSpectronic); *gravimetric methods*: filterable residue dried at 105 °C, suspended matter. The sampling, the sample preparation and analysis was made according to ISO standards.

## RESULTS AND DISCUSSION

The variation of pH in surface water is the result of the hydrolysis of various salts and dissolved gases (Iticescu et al., 2014). The pH values in all the sampling points were in the limits given by the Order 161/2006 for surface water, with values from 6.83 to 8.28 (see figure 2).

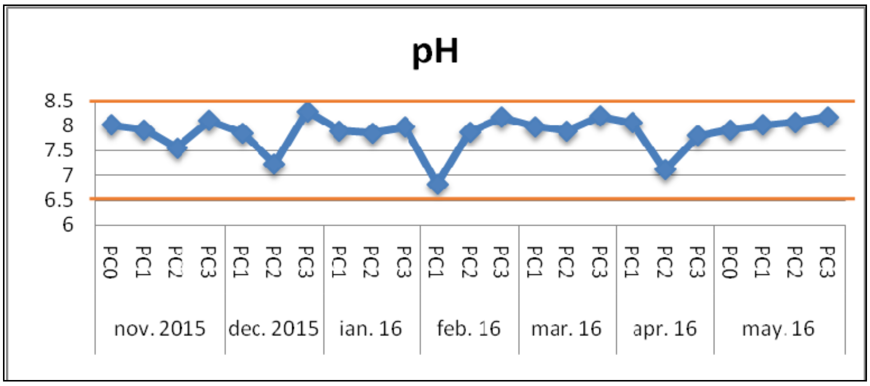



**Fig. 2.** *pH values from Chinteni rivulet*

The electrical conductivity of the water samples varied significantly and ranged from the maximum value of 1412 µS/cm recorded at the PC2 point to the minimum value 454 µS/cm, at the PC1 sampling point (see figure 3). At PC1 point, immediately after Lake Chinteni, is a lower conductivity due to the dilution with water leaking from the lake and springs from the area, and after the rivulet takes up wastewater, conductivity increases. The redox potential values are all negative, indicating an oxidizing environment consuming organic matter. The variation of the total dissolved solids is similar to conductivity.

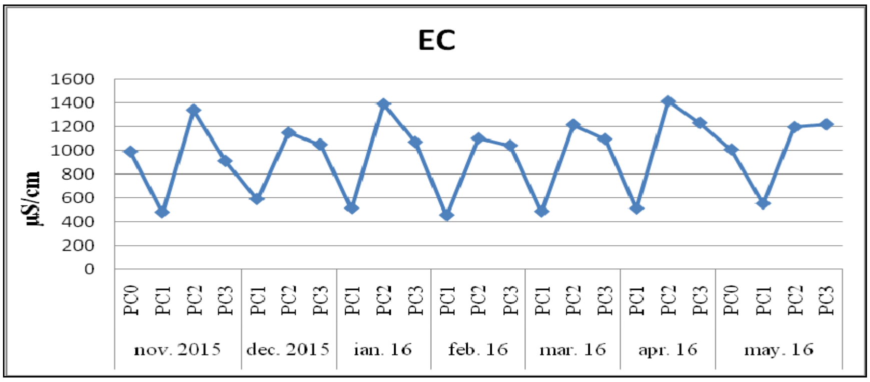
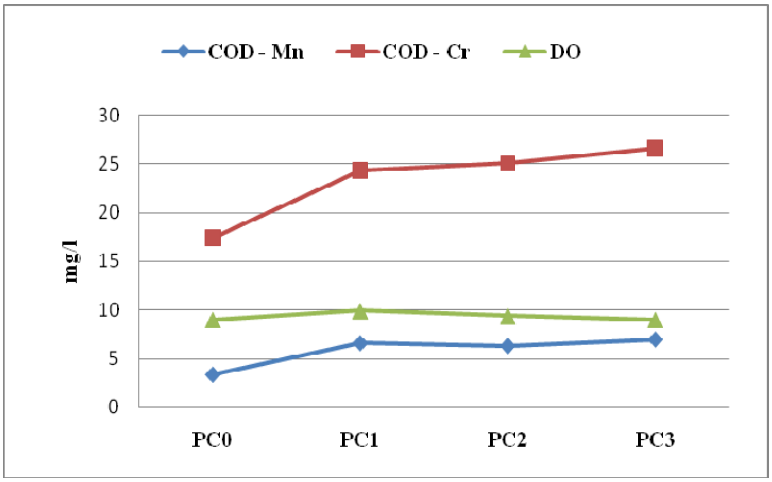



**Fig. 3.** *EC values from Chinteni rivulet*

For the oxygen regime parameters were observed fluctuations, especially in the case of COD-Cr. In the below figure (no. 4) are shown the average values from Chinteni rivulet.



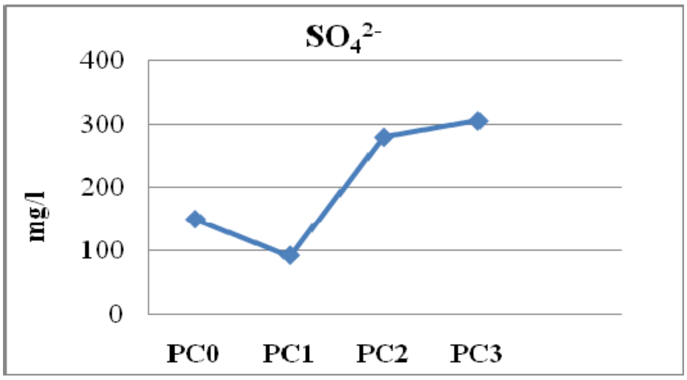

| Parameter | Category | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| **DO (mg/l $O_2$)** | 9 | 7 | 5 | 4 | <4 |
| **COD-Mn (mg/l $O_2$)** | 5 | 10 | 20 | 50 | >50 |
| **COD-Cr (mg/l $O_2$)** | 10 | 25 | 50 | 125 | >125 |

**Fig. 4.** *Average values for oxygen regime parameters from Chinteni rivulet and water categories*

The water quality of the Chinteni rivulet according to the measured values for DO is included in 1st category, and according to the values of COD-Cr and COD-Mn is in the 2nd category and in some periods in 3rd category (COD-Cr).

For chlorides the maximum recorded level was 58 mg/l in PC3 point (included in 3rd category), according to values from PC0 and PC1 sampling points the water quality is included in 1st category.

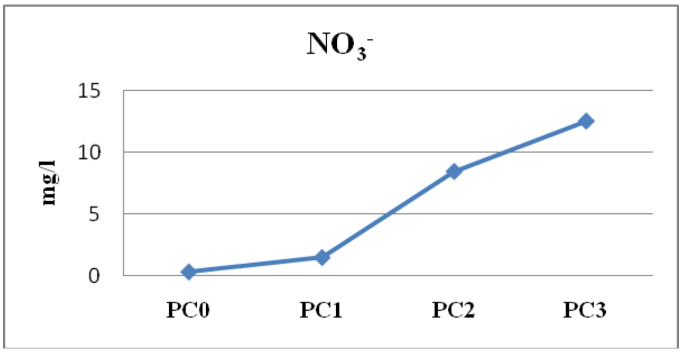
The values obtained for sulfates (see figure 5) have the tendency to increase from upstream to downstream, the 4th category is characteristic to PC2 and PC3 sampling points and 2nd category for PC0 and PC1 sampling points.




| **Parameter** | **Category** | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| **Sulfates (mg/l)** | 60 | 120 | 250 | 300 | >600 |

**Fig. 5.** *Average sulfates values from Chinteni rivulet and water categories*

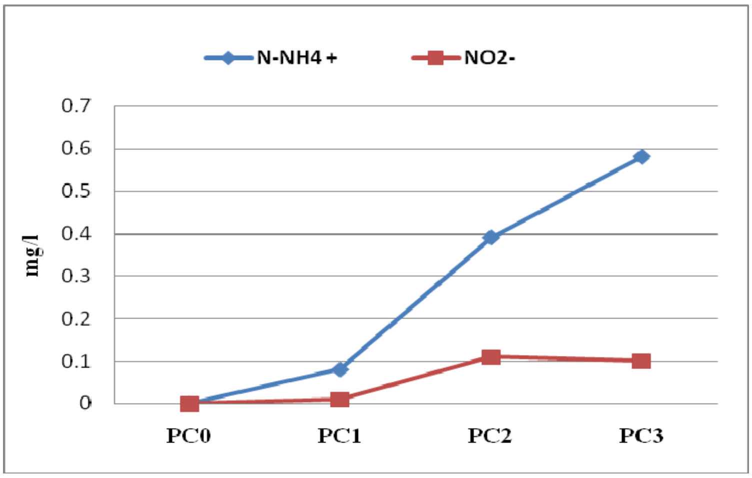
The maximum value for nitrate was recorded at PC3 point (19.2 mg/l in March 2016) and the minimum value (0.27 mg/l in May 2016) in PC0 sampling point (figure 6). According to the recorded values for nitrates, the water quality is on the 1st category at point PC0, 2nd category in PC1 point, 3rd category in PC2 point and 5th category in PC3 point.




| **Parameter** | **Category** | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| **Nitrate (mgN/l)** | 1.3 | 5 | 5.6 | 11.2 | >11.2 |

**Fig. 6.** *Average nitrate values from Chinteni rivulet and water categories*

For nitrite it was observed the same tendency of degradation of the water quality (figure 7), from upstream to downstream, the first two points (PC0 and PC1) are included in the 1st category and the last two (PC2 and PC3) in the 4th quality category.



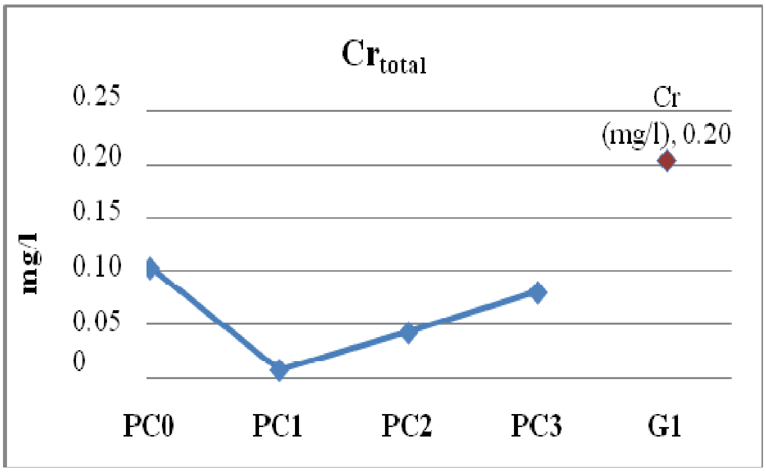

| Parameter | Category | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| **Ammonium (mgN/l)** | 0.4 | 0.8 | 1.2 | 3.2 | >3.2 |
| **Nitrite (mgN/l)** | 0.01 | 0.03 | 0.06 | 0.3 | >0.3 |

**Fig. 7.** *Average values for N-$NH_4^+$and $NO_2^-$ from Chinteni rivulet and water categories*

For point G1 (discharge) the mean value for ammonium is 5.26 mg/l, with a maximum of 10.64 mg/l and a minimum of 1.68 mg/l, the concentration of ammonium in this point is much higher than in other sampling point, influencing in a great manner the quality of rivulet downstream.

For fixed residue and suspended matter the smallest values were obtained in point PC1 due to aport of fresh water from springs and lake, which modifies the initial characteristics of the water (point PC0). In the rest of the points, the water quality of the Chinteni rivulet is included in the 2nd category. No limitation in surface water is prescribed by law (in Romania) for the suspended material content, the maximum recorded value for this parameter was 46 mg/l in PC3 sampling point and a minimum of 8 mg/l in PC0 sampling point.

Cromium and his compounds can be found in waters only in trace amounts and can be discharged in surface water through various industries. The occurrence of dissolved Cr(III) and Cr(VI) in untreated source water is affected, partialy by aqueous pH. Cr(III) generally is insoluble between pH=6–10 and Cr(VI) is increasingly soluble above pH 6 to virtually 100 percent soluble above pH 8 (Mills and Cobb, 2015).




| Parameter | Category | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| $Cr_{total}$ (mg/l) | 0.025 | 0.050 | 0.100 | 0.250 | >0.250 |

**Fig. 8.** *Average values for $Cr_{total}$ from Chinteni rivulet and water categories*

The highest values recorded for this indicator were found in G1 (discarge) sampling point, with a maximum of 0.24 mg/l in May 2016. The total cromium content in Chinteni rivulet was found in range of 0.005 – 0.116 mg/l (see figure 8). Acording to this values, the water quality is in the 1st category at PC1 sampling point , 2nd category in PC2 point and 3rd category for PC0 and PC3 sampling points.

To calculate the WQI for Chinteni rivulet were chosen two data sets: the mean values for al sampling dates and the values obtained in May 2016. The values of WQI were calculated using the formula writen above (ecuation 1) and the MCL values for 2$^{nd}$ category for surface water from 161/2006 Order.

The WQI value obtained for the mean values (november 2015 – may 2016) is 69.50 and for the values recorded in may 2016 is 69.31. These values indicate fair water quality for Chinteni rivulet.

## CONCLUSIONS

From the analyses of the 15 physico-chemical parameters we drew the conclusion that the water of Chinteni rivulet is occasionally deteriorated and the conditions somtimes deviate from the natural or desirable levels.

The research hypothesis is confirmed: the sources of anthropogenic pollution put pressure on the water quality (from upstream to downstream) and the tendency of increasing pollution is directly proportional to the population density and the intensification of the economic activities.

From the perspective of the Normative 161/2006 on surface water quality, the results obtained divide the water of the rivulet in two distinct sections:

1. Upstream (PC0 and PC1) where the water quality for most of the investigated parameters is in the 1$^{st}$ and 2$^{nd}$ category;
2. Downstream (PC2 and PC3) with inferior water quality - 7 of 11 parameters, wich are normated, are in 3$^{rd}$, 4$^{th}$ and even in 5$^{th}$ category.

The highest concentrations recorded throughout the course of the Chinteni rivulet are for nitrate, nitrite, sulphates, chemical oxigen demand, chlorides and total chromium chemical parameters.

The investigated wastewater discarged in the rivulet (point G1) brings a large supply of chromium, ammonium, nitrite and organic mater.

The chemical risk assessment indicated a moderate degree of pollution of the Chinteni rivulet with WQI of 69.5.

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