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ORIGINAL RESEARCH PAPER

ANALYSIS OF WATER QUALITY FOR TWO RIVERS LOCATED NEAR A MINING AREA

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Abstract: The paper presents a study that was focused on the analysis of the existence of metals in the rivers located near the salt mine Targu Ocna, Romania. The points identified near mining areas and the proposal for performing analyzes regarding the presence of metals in surface waters are the Slanic River and the Trotus River.
The purpose of this study is to analyze the physico-chemical parameters: (*p*H, electrical conductivity, dissolved oxygen, turbidity, temperature), selected heavy metals (Fe, Mn, Zn, Cr), Mg and Al of the Slanic River and the Trotus River located near the salt mine and to investigate the level of metal contamination due to mining activities. The samples were collected at two points in the Slanic River and two points for the Trotus River. The physico-chemical parameters were measured *in-situ* with portable equipment and within the Water Analysis Laboratory of "Vasile Alecsandri" University of Bacau. The values registered for the physico-chemical parameters were compared with the permissible limits by the legislation.

Keywords: *dissolved oxygen, electrical conductivity, metals, rivers, salt mines*

INTRODUCTION

The rapid industrialization, in the vast majority of developing countries, represents a very serious problem for the water quality [1 – 5]. Among the main pollutants of the rivers are metals that can pose a threat to human health, the aquatic environment and animals [6, 7]. Metals can produce a various environmental damage and aquatic organisms due to their high concentrations and penetration of water [8, 9].
Generally, the presence of metals can be from the contaminated land, abandoned mines, rock and minerals but also from industry waste sources and agricultural activities [8 – 14].
Due to the storage of industrial, agricultural and domestic waste and their discharge into the water, the rivers suffer various quality changes and are become one of the most polluted water categories and can lead to an increase in the level of metals [14 – 17]. Some metals have an important role in enzymatic activity, but in high concentrations can become toxic [15 – 21].
Most studies have shown that one of the main factors of rivers pollution by metals (after the landfill of industrial, agricultural and domestic waste) is represented by the wastewater from mining activities that may produce different effects on the environment [10, 12]. The mining activity is a source of metal contamination that can affect the ecosystem in relatively small areas, but can have a significant impact on the environment [10, 22 – 24].
The purpose of this study is to analyze some representatives physico-chemical parameters (*p*H, electrical conductivity, dissolved oxygen, turbidity, temperature), selected heavy metals (Fe, Mn, Zn, Cr), Mg and Al of the Slanic River and the Trotus River located near to a salt mine, and to compare the values with the Romanian legislation permissible limits.

MATERIALS AND METHODS

The study area

For the present study, two rivers, Trotus River (Figure 1) and the Slanic River (Figure 2), flowing near the mining area have been identified, namely the Salt Solution Section from the Targu Ocna Salt Mine, Bacau, Romania.
Slanic River is an affluent of the Trotus River. It crosses the SE area to the SW, at about 50 m from the Salt Solution Section, and the Trotus River flows in the N-SE direction at a distance of approximately 300 m (Bacau County, Romania).

Figure 1. *Sampling points in the Trotuş River* [25]

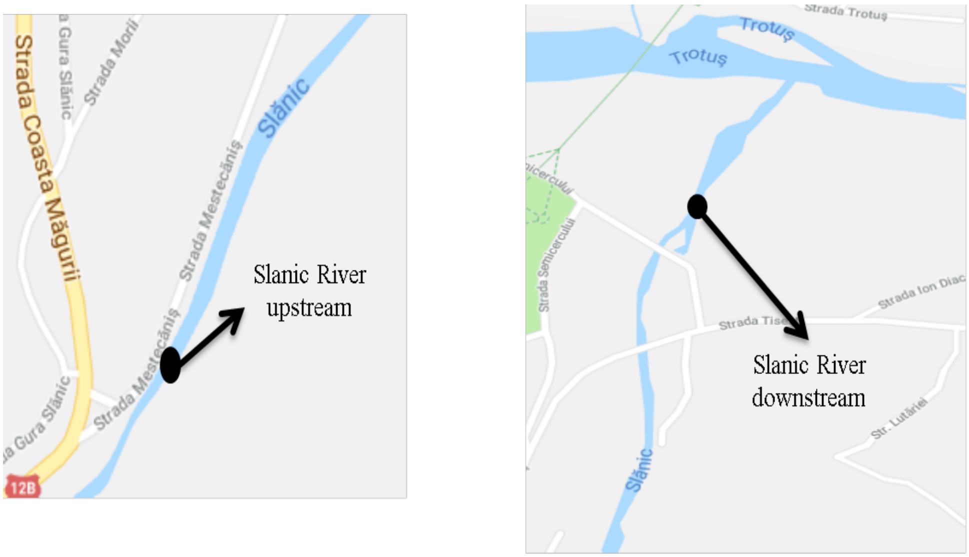

Figure 2. *Sampling points in the Trotuş Slanic* [25]

Collecting samples

In the present study, two samples of surface water were collected in April 2018 from the rivers Trotus and Slanic upstream and downstream of the mining area.
Samples were collected in 500 mL polyethylene (PET) recipients. After sampling, the samples were marked to correspond to the site and transported for analysis.
Sampling of surface water has been made to evaluate the degree of contamination of water in the study area.

Analysis

Measurements of physico-chemical parameters (*p*H, electrical conductivity, turbidity, temperature and dissolved oxygen) were carried out using the following equipment:

Oxi 3210, pH 3210, Cond 3210, TURB 430 made by WTW GmbH companies, Weilheim, Germany.

The concentration of the Mg, Al and heavy metals selected (Fe, Mn, Zn, Cr), in the two rivers, were determined in the laboratory analysis of the water from the University "Vasile Alecsandri", Bacau, using SQ NOVA 60A spectrophotometer, made in Germany by Merck Company (Figure 3).

Figure 3. *Samples analysis in the laboratory*

The standards for calibrating instruments were purchased from GmbH, Weilheim, Germany.

RESULTS AND DISCUSSION

Analysis of physico-chemical parameters in water

The results of the performed analyzes were compared with the surface water quality classes [26].

The measurements on *p*H, electrical conductivity, turbidity, temperature and dissolved oxygen performed are presented in Table 1.

Table 1. *Results of physico-chemical parameters of water*

Measuring point	*p*H	Turbidity [UNT]	Electrical conductivity [$\mu S \cdot cm^{-1}$]	Dissolved oxygen [$mg \cdot L^{-1}$]	Temperature [˚C]
Slanic River upstream (RSU)	8.3	29.2	509	6.93	17.4
Slanic River downstream (RSD)	8.2	24.5	601	6.94	17.5
Trotus River upstream (RTU)	8.4	157	375	7.65	14
Trotus River downstream (RTD)	8.2	147	368	6.94	15.4

The *p*H of the water in the two rivers (Figure 4) upstream and downstream of the mining area is in the range of 8.2 - 8.4. The *p*H of the Trotus River and of the Slanic River are low alkaline.
The smallest value was recorded downstream both in the Slanic River and the Trotus River, and the highest value is recorded upstream of the Trotus River.

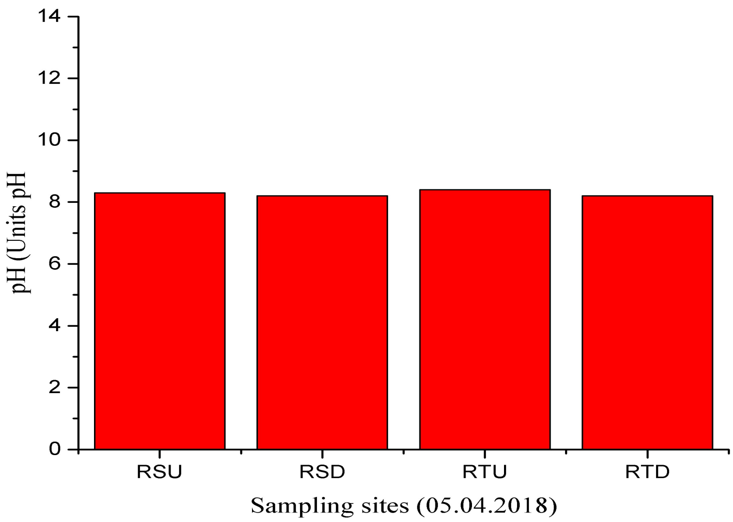

Figure 4. *pH value in analyzed areas*

The electric conductivity (Figure 5) in water samples varies between 368 μS·cm^{-1} and 601 μS·cm^{-1}. In the sampling point downstream of the river Slanic indicates the highest value, while the lowest value was recorded in the Trotus river upstream.

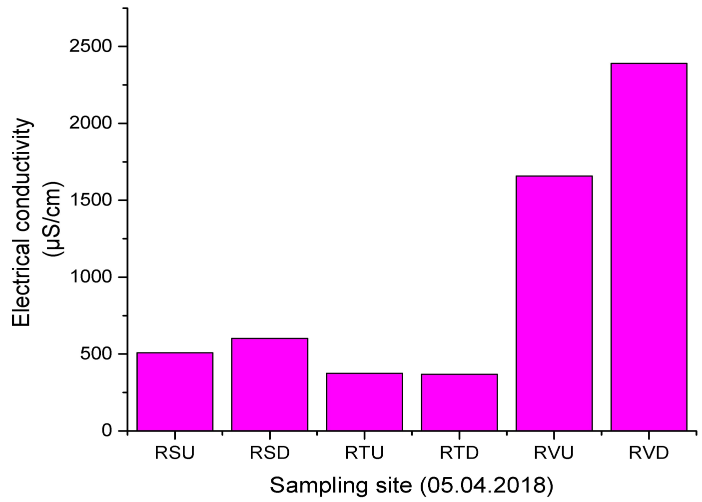

Figure 5. *The value of electrical conductivity in the analyzed areas*

On the basis of the analyses carried out, the highest values of turbidity were recorded upstream and downstream of the Trotus River compared to the Slanic River (Figure 6).

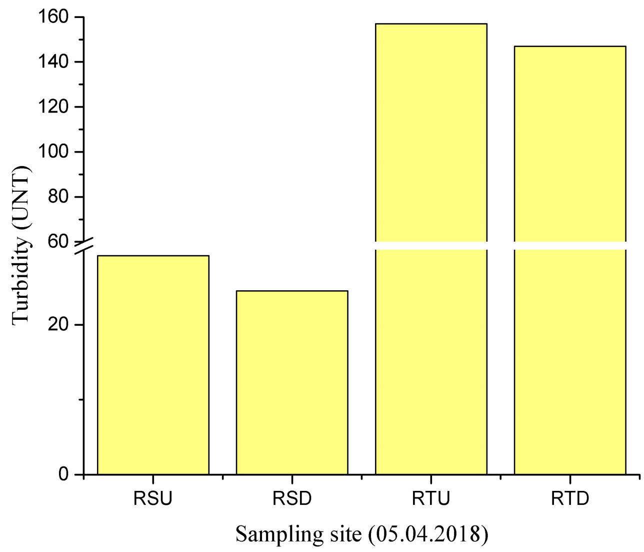

Figure 6. *The value of turbidity in the analyzed areas*

The values of the dissolved oxygen from the Trotus River and the Slanic River (Figure 7) are between 6.94 - 7.65 UNT. All the results of the analyzed samples are in the category of classes I and II.

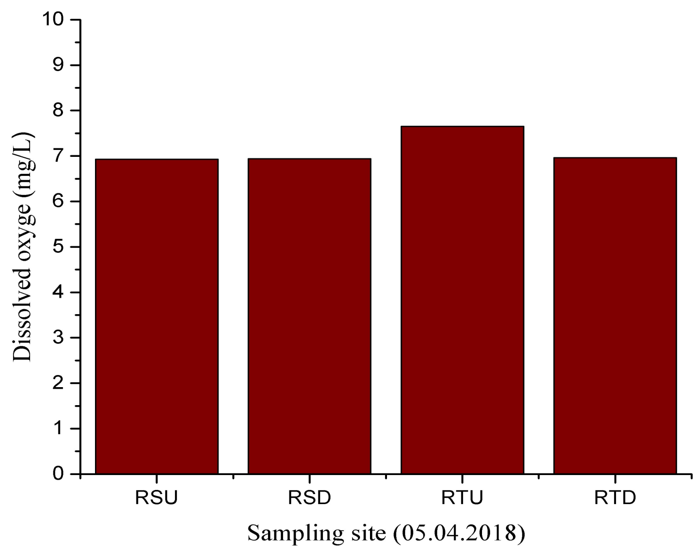

Figure 7. *The value of dissolved oxygen in the analyzed samples*

The temperature for the Trotus River upstream and downstream of the mining area varies between 14 °C and 15.4 °C. For the Slanic River, the temperature upstream of the mining area is 17.4 °C and downstream of the mining area is 17.5 °C (Figure 8).

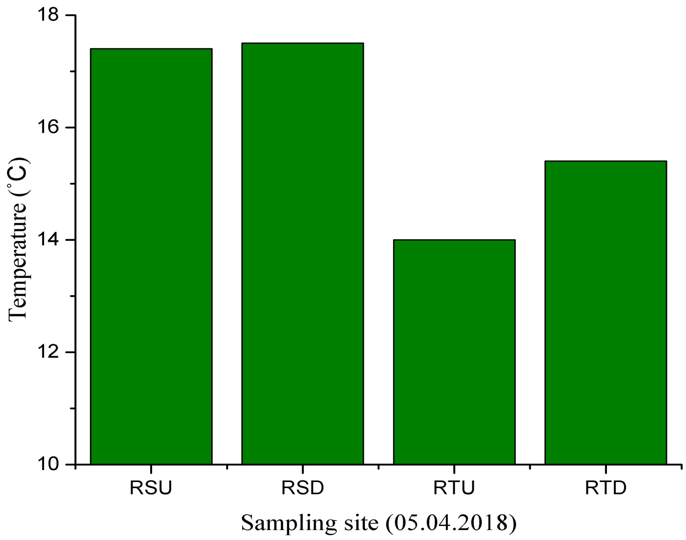

Figure 8. *The temperature in analyzed samples*

Metal analysis

Figure 9 represents the concentration of heavy metals (Fe, Mn, Zn, Cr), Mg and Al in the two rivers Slanic and Trotus near the mining area.

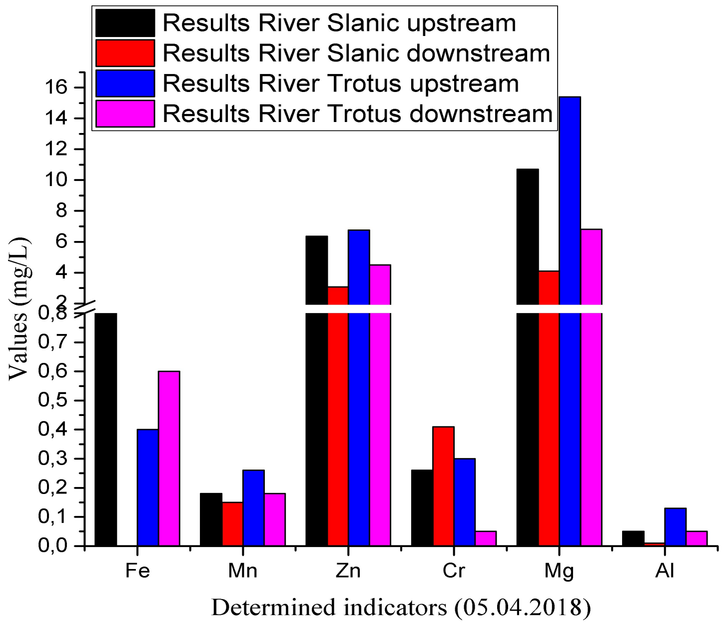

Figure 9. *Values of metal concentrations in analyzed samples*

Upstream values concentrations of Fe, Mn and Mg from all sampling points have been found high in relation with the quality class categories [26]. Concerning the Zn concentrations in the upstream samples analyzed (RSU and RTU) a small overpass (1.30 times) was determined.

In the case of Cr and Al, the values determined for the two rivers upstream and downstream fall within the category of quality classes.
In all cases for the downstream zones of the two rivers, lower metal concentrations were registered, compared with upstream zones.

CONCLUSIONS

Over time, mining activities have been and are considered to be a source of environmental pollution. For this purpose, analyzes were performed near the mining area in order to determine the water parameters.
Analysis of the water samples taken from the rivers in the vicinity of the mining area showed that the *p*H of the analyzed samples was higher than 7, falling into the category of low alkaline *p*H.
The results of the analyzes performed on the four samples of surface water (RSU, RSD, RTU and RTD) near the mining area (Salt Solution Section) showed that, in most samples, the concentrations of Fe, Mn, and Mg (RSU and RTU) exceed the values in the quality classes.
With regard to concentration values of Al and Cr (RSU, RSD, RTU and RTD), they fall within the category of quality classes.
High metals concentrations in water samples may be due also to anthropogenic contaminants and natural sources.

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