

ANALYSIS OF SOME PHYSICAL-CHEMICAL INDICATORS IN TWO SECTIONS OF THE CRICOVUL DULCE RIVER

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Abstract

In the present work, the main physical and chemical elements that define the water quality of the Cricovul Dulce river, within the Ialomita hydrographic basin, were monitored, a river that runs through the counties of Prahova and Dambovita.

The central objective of this work was to analyze the physico-chemical indicators of the Cricovul Dulce river, of pH, temperature, oxygen, saturation, turbidity, BOD, COC-Cr level, in two sections, respectively upstream near the city of Moreni and within the radius of Baltita.

After studying the mentioned parameters, the Cricovul Dulce river waters were classified into quality classes in the analyzed sections.

Keywords: water, river, physical indicators, chemical indicators

1. INTRODUCTION

Since water quality does not remain constant over time because it varies due to natural or artificial impurity, a periodic control of the values of the physico-chemical indicators that define surface water quality is required. The quality assessment of surface waters is a complex process, dependent on a series of criteria, methods and procedures that vary from one European state to another. Given the fact that water is a vital natural resource with universal distribution that maintains and conditions human life, "the satisfaction of this need directly depends on its quality, and the geological and physico-chemical conditions dictate the qualitative state of water." [9].

The motivation for choosing this topic is given precisely by the importance and growing concern of our contemporary society for ensuring a quality of water or, through a specific European term, an integrated monitoring of the quality of water on the territory of our country.

Surface waters contain three large categories of substances, such as: minerals from the lithosphere either through the natural degradation of rocks or through human activities; organic substances that come either from the remains of plant and animal organisms, or from anthropogenic sources of pollution (for example, medicines, pesticides, chemicals, detergents, household water discharged into nature and untreated, etc.); dissolved gases either from the atmosphere or from chemical reactions occurring in water (eg nitrogen, oxygen, carbon dioxide and sulfur dioxide, etc.). Therefore, the quality of water directly depends on the substances that compose it.

"Surface water quality is determined by three large categories of parameters, such as: basic parameters (such as temperature, pH, conductivity, saturation, turbidity), parameters indicating persistent pollution (organo-halogen compounds, cadmium, mercury, mineral oils, etc.), optional parameters (biochemical oxygen demand – BOD, total organic carbon, detergents, heavy metals,

arsenic, boron, sodium, cyanides, streptococcus, etc.)."

[6]. From a statistical point of view, water quality indicators are of the nature of continuous variables or, better said, of quantitative characteristics that can take a numerical value, within certain limits. Carrying out as much analysis and statistics as possible can determine the accurate estimation of a real average value of water quality [1].

2. MATERIALS AND METHODS

Establishing the collection stations and the sampling calendar

The Cricovul Dulce River or, in short, the Cricov River is part of the Ialomita hydrographic basin, being the third in size and importance river in Dambovita County, after Ialomita and Dambovita Rivers. It crosses Dambovita and Prahova counties, and after a total length of 69 km, the Cricovul Dulce river flows into Ialomita [8].

In Dambovita county, the Cricovul Dulce river passes through Moreni and Ion Luca Caragiale localities, and in Prahova county, through Baltita locality (in the past, Comanacul), Manesti commune, having as tributaries the rivers Provita and Iazul Morilor.

The collection of water samples is the most important stage in carrying out the whole process of analyzing the physical and chemical indicators of the Cricovul Dulce river, because the water samples must have representative characteristics, and under no circumstances does it have to contain errors in the measurement of water quality due to faulty techniques or improper conditions preparation of the material.

For the collection of data related to the physical-chemical indicators of the Cricovul Dulce river, we established two sections of the studied river as collection stations, respectively:

- I. Cricovul Dulce upstream Moreni, Dambovita County;
- II. Cricovul Dulce, Baltita locality area, Prahova County.

"The main physico-chemical indicators that define the chemistry of surface waters in our area and characterize them from a qualitative point of view are the following: temperature, pH, transparency, dissolved oxygen (OD), organic substances, biochemical oxygen demand (BOD) magnesium, calcium, sodium, total suspensions and residues [4]. The methods used for sampling were chosen in accordance with European standards, such as EN ISO/CEI 17025: 2006, SR EN ISO 5667-1:2011, SR EN ISO 5667-6:2011.

The sampling calendar was established as following:

I. Cricovul Dulce upstream Moreni, Dambovită County. In this section of the river, sampling was carried out in 2020, in the months of February, March, May, June, July, August, October and November;

II. Cricovul Dulce, Baltita locality area, Prahova County. In this section, the samples were taken in 2020, in the months of February, March, May, June, July, August, October and November.

The most important information that directly affects the quality of the Cricovul Dulce river is provided by the following indicators:

I. Physical indicators: temperature, pH, turbidity.

II. Chemical indicators: dissolved oxygen (DO), oxygen saturation, biochemical oxygen demand per 5 days (BOD), and determination of oxygen consumption by the potassium bichromate method (COC-Cr).

3. RESULTS OBTAINED

The results obtained are presented in the following tables:

Table 1. Physical indicators analyzed (temperature)

Nr. crt.	River/ Section	Date of sample collection	Temperature (°C)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	4.0
2.		10.03.2020	9.0
3.		11.05.2020	16.0
4.		09.06.2020	20.0
5.		22.07.2020	20.0
6.		10.08.2020	23.0
7.		12.10.2020	15.0
8.		10.11.2020	6.0
9.	CRICOVUL DULCE BALTITA	26.02.2020	6.0
10.		12.03.2020	10.0
11.		12.05.2020	20.0
12.		11.06.2020	22.0
13.		23.07.2020	23.0
14.		13.08.2020	21.0
15.		14.10.2020	12.0
16.		12.11.2020	7.0

The temperature of the Cricovul Dulce river is within normal parameters, with an average value of 18.0 °C during the studied year, registering an increase in the time span between the end of winter and the beginning of spring (March-May, 9 °C-16 °C), and respectively a decrease in the time span of October -November (15 °C-6 °C).

Table 2. Physical indicators analyzed (pH)

Nr. crt.	River/ Section	Date of sample collection	pH value (pH units)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	8.1
2.		10.03.2020	8.2
3.		11.05.2020	8.1
4.		09.06.2020	8.2
5.		22.07.2020	8.1
6.		10.08.2020	8.1
7.		12.10.2020	8.2
8.		10.11.2020	8.1
9.	CRICOVUL DULCE BALTITA	26.02.2020	8.0
10.		12.03.2020	8.0
11.		12.05.2020	8.1
12.		11.06.2020	8.2
13.		23.07.2020	8.1
14.		13.08.2020	8.1
15.		14.10.2020	7.9
16.		12.11.2020	7.9

The normal pH value for surface waters is between 6.5-8.5, and the pH value of the Cricovul Dulce river is between 7.9-8.2 in the monitoring span for the studied stations.

Table 3. Physical indicators analyzed (turbidity)

Nr. crt.	River/ Section	Date of sample collection	Turbidity (NTU)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	-
2.		10.03.2020	7.0
3.		11.05.2020	3.0
4.		09.06.2020	-
5.		22.07.2020	101.0
6.		10.08.2020	-
7.		12.10.2020	6.3
8.		10.11.2020	-
9.	CRICOVUL DULCE BALTITA	26.02.2020	-
10.		12.03.2020	54
11.		12.05.2020	58
12.		11.06.2020	-
13.		23.07.2020	1420
14.		13.08.2020	-
15.		14.10.2020	96
16.		12.11.2020	-

Turbidity is the disturbance or haziness of a liquid characterized by the lack of transparency of the water, a phenomenon caused by invisible fine particles or solid suspensions present in the water. After taking the samples from the 2 collection stations, it was found that at the Baltita station the turbidity is higher (for example, in July 2020 the turbidity was 1420 NTU), and upstream at Moreni the turbidity was lower (for example, also for the month of July 2020, the value was 101 NTU).

Table 4. Chemical indicators analyzed (dissolved oxygen)

Nr. crt.	River/ Section	Date of sample collection	Dissolved oxygen (mg/l)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	13.9
2.		10.03.2020	11.4
3.		11.05.2020	10.1
4.		09.06.2020	9.65
5.		22.07.2020	10.1
6.		10.08.2020	9.15
7.		12.10.2020	11.4
8.		10.11.2020	11.9
9.	CRICOVUL DULCE BALTTA	26.02.2020	11.8
10.		12.03.2020	10.7
11.		12.05.2020	8.91
12.		11.06.2020	10.2
13.		23.07.2020	8.08
14.		13.08.2020	9.29
15.		14.10.2020	8.21
16.		12.11.2020	11.1

Dissolved oxygen (DO) is one of the important chemical indicators used to determine the quality of surface waters, consisting of the amount of oxygen dissolved in water, at the temperature at the time of taking the water sample.

In the two sections of the Cricovul Dulce river, dissolved oxygen has higher valences in the Moreni upstream area, compared to the Baltita area. In the months of February-March 2020, the dissolved oxygen value was higher in the Moreni upstream area, respectively 13.9 and 11.4 mg/l. The minimum value of this parameter was recorded in July in the Baltita sampling station (8.08 mg/l)

Analyzing the data of the physico-chemical indicators of the Cricovul Dulce river, it can be said that the value of dissolved oxygen (OD) is within normal parameters, with values between 8-14 mg/l.

Table 5. Chemical indicators analyzed (saturation)

Nr. crt.	River/ Section	Date of sample collection	Saturation (%)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	106
2.		10.03.2020	98
3.		11.05.2020	102
4.		09.06.2020	106
5.		22.07.2020	111

6.	CRICOVUL DULCE BALTTA	10.08.2020	107
7.		12.10.2020	113
8.		10.11.2020	95.3
9.		26.02.2020	94.9
10.		12.03.2020	94.4
11.		12.05.2020	98.0
12.		11.06.2020	117
13.		23.07.2020	94.2
14.		13.08.2020	104
15.		14.10.2020	76.2
16.		12.11.2020	91.1

It is considered that in order to fall into higher quality classes, surface waters must present oxygen saturations above 80%. In the studied area only in October the saturation was below the MAC values, respectively, 76.2%. In the rest of the monitored period, the oxygen saturation in all months analyzed in the two sampling stations was over 80%.

Table 6. Chemical indicators analyzed (biochemical oxygen consumption)

Nr. crt.	River/ Section	Date of sample collection	BOD (mg/l)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	2.1
2.		10.03.2020	2.3
3.		11.05.2020	2.3
4.		09.06.2020	2.3
5.		22.07.2020	4.5
6.		10.08.2020	1.3
7.		12.10.2020	1.4
8.		10.11.2020	2.1
9.	CRICOVUL DULCE BALTTA	26.02.2020	2.4
10.		12.03.2020	3.3
11.		12.05.2020	2.4
12.		11.06.2020	2.0
13.		23.07.2020	8.8
14.		13.08.2020	3.4
15.		14.10.2020	3.5
16.		12.11.2020	2.6

The chemical indicator BOD provides important indications about the content of microorganisms and biodegradable organic substances present in the water sample from the Cricovul Dulce river.

The determination of the biochemical consumption of dissolved oxygen after 5 days made by analyzing the water sample was performed in the two stations of the Cricovul Dulce river. From table 6 it can be seen that low values of the biochemical oxygen consumption were recorded in the months of August and October at the Moreni station (1.3 and 1.4 mg/l) and at the Baltita station in June (2.0 mg/l). The maximum value of this parameter was recorded in July in Baltita station (8.8 mg/l).

Table 7. Chemical indicators analyzed (chemical oxygen consumption)

Nr. crt.	River/ Section	Date of sample collection	COC-Cr (mg/l)
1.	CRICOVUL DULCE UPSTREAM MORENI	25.02.2020	6.2
2.		10.03.2020	8.88
3.		11.05.2020	8.15
4.		09.06.2020	10.8
5.		22.07.2020	24.8
6.		10.08.2020	7.97
7.		12.10.2020	4.8
8.		10.11.2020	7.7
9.	CRICOVUL DULCE BALTITA	26.02.2020	9.42
10.		12.03.2020	9.00
11.		12.05.2020	9.42
12.		11.06.2020	14.6
13.		23.07.2020	49.9
14.		13.08.2020	11.5
15.		14.10.2020	14.4
16.		12.11.2020	15.5

The chemical oxygen consumption COC-Cr (potassium bichromate method) represents the concentration of the mass of oxygen equivalent to the amount of potassium bichromate consumed for the oxidation in an acidic environment of the dissolved and suspended organic matter present in the studied river water. Relatively constant values of this parameter are observed for the monitoring period, with the exception of July with a recorded value of 49.9 mg/l.

Comments on the inclusion of the studied parameters in the MAC norms and the inclusion of water in quality classes

The analysis of the physico-chemical indicators of the Cricovul Dulce river was done in compliance with the European legislation, and with the evaluation of the parameters that within the MAC norms. Each analyzed parameter has a maximum allowed limit, regulated by the European Union Directives regarding the surface water regime. In order to improve the current state of the indicators, it is necessary to carry out a real analysis, then compare the results and correct the parameters where the concentration has exceeded the allowed limit.

At the level of the European Union, Directive 2008/105/EC was adopted on environmental quality standards, a regulation that imposes the standard environmental quality values valid for surface waters, but also the maximum allowed concentrations valid for priority substances and other pollutants that affect the quality the water.

The quality standards for surface waters define the maximum concentrations allowed for hydrographic basins, and following the analysis of the physico-chemical indicators of the Cricovul Dulce river, the MAC values

were close to the European requirements to ensure the protection of the environment and especially the health of the people and the studied ecosystem (table 8).

Regarding the classification of the water of the Cricovul Dulce river in quality classes, it can be said that in some places the studied water meets the conditions or requirements of ensuring a quality water, being classified as following:

- ☐ Temperature - it is not regulated by class.
- ☐ pH - between 6.5-8.5, 2nd quality class.
- ☐ Turbidity - quality class I to II.
- ☐ Dissolved oxygen, between quality classes I and II;
- ☐ Saturation – 2nd quality class.
- ☐ CBO₅, between I and II quality classes;
- ☐ CCO-Cr, between quality classes I and II, isolated class III.

4. CONCLUSIONS

1. The water temperature moderately influenced the accumulation of oxygen in the water, higher values of the amount of oxygen dissolved in the water being registered in the cold seasons and lower values, in the warm season;
2. The pH of the Cricovul Dulce river were within the maximum norms allowed during the monitoring period for the two sampling stations;
3. Turbidity showed higher values in the warm season;
4. In the Moreni upstream section, the dissolved oxygen concentration remained around 10-11 mg/l throughout 2020, with the extreme values being 13.9 mg/l in February and 9.15 mg/l , in August;
5. In the Baltita section, the dissolved oxygen concentration remained around 9-10 mg/l throughout 2020, with the extreme values being 11.8 mg/l, in February, and 8.08 mg/l , in July;
6. Oxygen dissolved in water moderately influenced the accumulation of organic substances in the analyzed sections of the Cricovul Dulce river;
7. The oxygen saturation of the waters of the Cricovul Dulce river had a value over 80% throughout the monitoring period, respecting the quality norms of surface waters;
8. At the Moreni station, biochemical oxygen consumption and dissolved oxygen showed strong correlations, in the analyzed interval, microorganisms representing the main consumer;
9. According to the results obtained in the two collection points, in the Moreni and Bălțița sections, the water of the Cricovul Dulce river fits into the I and II quality classes, the physico-chemical quality values demonstrating its potability.

5. REFERENCES

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Table 8. Comparison with maximum allowed concentrations

Indicator/ MAC	Physical indicators			Chemical indicators			
	Water temperature	pH	Turbidity	Dissolved oxygen	Saturation	BOD	COC-Cr
Unit	°C	pH units	UNT/NTU	mg /l	%	mg O ₂ /l	mg O ₂ /l
Indicators Cricovul Dulce	4-6 – cold season 20-23 – warm season	7.9-8.2	3-1420	8.08-13.9	76-113	1.3-8.8	4.8-49.9
MAC (Maximum Allowed Concentration	-	6.5 – 9.5	Max. 5 NTU	Minimum 4.0 – for winter Minimum 6.0 – for summer	not less than 80%	3.0 / 25 NTPA001 300 NTPA002	15.0/ 125 NTPA001 500 NTPA002