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ASSESSMENT OF WATER QUALITY FROM ACCUMULATION STÂNCA-COSTEȘTI

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Abstract

Water is one of the natural resources most widespread on Earth, between living organisms and water being an indispensable link. The aim of this research was to assess the water quality of the Stânca-Costeşti accumulation based on the results obtained from the determination of physical- chemical parameters and toxic pollutants. Stânca-Costeşti accumulation is situated on the border between Romania and Moldova in Botosani County. The elements determined for each sample related to the studied section are represented by: pH, dissolved oxygen, biochemical oxygen demand (B.O.D.), nitrite, nitrate, chlorides, sulphates, cadmium, nickel, lead, zinc, copper and chromium. In order to establish the values of determined elements were applied standardized analytical methods. The average concentrations of analyzed heavy metals were below maximum permissible concentration for Ist class of quality. As a general conclusion based on these results, we can say that water from Stânca-Costeşti accumulation fall within the IInd class of quality in terms of the oxygen and in the Ist class of quality in terms of nutrients and heavy metals.

Key words*: Stânca-Costeşti accumulation, water chemical composition, water quality.*

INTRODUCTION

Water is one of the natural resources most widespread on Earth. Between living organisms and water being an indispensable link. Man is made up of 70% of water (Benchea, 2011). Of all types of water, the most important is the freshwater because human life would be impossible without it. Human civilization has been built based on water availability.

Stânca-Costeşti accumulation is situated in Botosani County, on Prut River, on the border between Romania and Moldova (Romanescu and Stoleriu 2017; Stoleriu et al., 2019). Stânca-Costeşti accumulation is located at an average altitude of 200 m, in an area where the major riverbed width of 3-4 km is strangled and reduced to 350-400 m by coral limestone, which basically is a natural dam, presenting optimal natural conditions for creating a retention capacity of around 1.0-1.5 billion m^3.

Stânca-Costeşti accumulation was opened in 1978, being located on the Prut River, about 580 km from its confluence with the Danube. The lake was constructed by a dam with a height of 47 m and a length of 7400 m, retaining a volume of water of about 735 million m^3 at the N.N.R., with an area of 59 km^2 and a maximum depth of 41.5 m, with bottom drain (Vartolomei, 2009).

Stanca-Costesti is the largest accumulation of water on the Prut River, being the second largest in Romania. Stanca-Costesti accumulation was jointly built by the two riparian states (Romania and the Republic of Moldova), to mitigate the effects of the high floods, to prevent damages caused by floods, ensuring the water supply of the population, industry, hydropower production as well as irrigation and fish farming activities.

Natural waters contain various mineral and organic substances, dissolved or in the form of colloids or suspended solids, which occur naturally and do not allow the use of these waters directly for consumption (Dăscălescu et al., 2011; Teodosiu et al., 2009). Studies on the quality of water in the systems of rivers or lakes in Eastern Europe have been carried out by

Albulescu et al., 2010, Dughilă et al., 2010, Benchea et al., 2011, Dăscăliţă, 2011, Romanescu et al., 2012, Lazu et al., 2019a.
Nutrients play a significant role for the environmental state of lakes, mainly because the primary production of lakes is strongly influenced by nutrient availability (Popescu et al., 2019). The aim of this research was to assess the water quality of the Stânca-Costeşti accumulation based on the results obtained from the determination of physical - chemical parameters and toxic pollutants.

MATERIALS AND METHODS

In order to establish water quality from Stânca-Costeşti accumulation (Figure 1), water sampling was carried out in four control sections, namely: from Manoleasa Village, middle of the lake, lake reservoir and dam outlet. Sampling took place in May, June, August and September, sampling points being established in order to provide relevant information for each section of water accumulation.

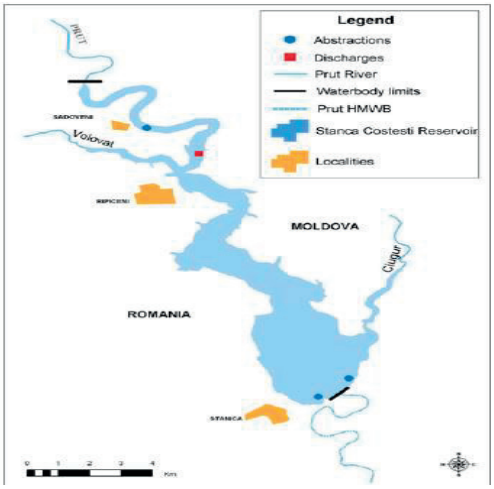

Figure 1. The geographical position of Stânca-Costeşti accumulation
(Source: Petru Şerban and Rădulescu Daniela, 2004)

Collecting the water samples for determination of chemical indicators was performed according to current standards, in sampling containers, from plastic and brown borosilicate glass which prevents light penetration that may have an influence on the organisms present in water and can cause unwanted chemical reactions.
The elements determined for each sample related to the studied section are represented by: pH, dissolved oxygen, biochemical oxygen demand (B.O.D.), nitrite, nitrate, chlorides, sulphates, cadmium, nickel, lead, zinc, copper and chromium.
In order to establish the values of determined elements were applied standardized analytical methods.
Quantitative determination of some pollution indicators (nitrites, nitrates, sulphates) was performed by spectrometry using an ATI UNICAM spectrophotometer.
The levels of heavy metals from the water samples were determined using an atomic absorption spectrophotometer type Shimadzu 6300, and an atomic spectrometer type GBC Avanta.

RESULTS AND DISCUSSIONS

Water pH
Hydrogen ion concentration (pH) - determines the activity of hydrogen ions, hence the ability of the water to be acidic, neutral or alkaline, thus highlighting the level of physico-chemical and biological processes in it (SR ISO 10523-97). The results obtained from the determinations are presented in the table 1.
From the comparison of the data presented in table 1 it can be observed that the pH values were similar during the analyzed periods.
The highest values were obtained, in all four sections taken into control, during 18.06.2019 and 09.08.2019 periods.

Table 1. pH values in the 4 sampling points

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	8.23	8.56	8.44	7.90	8.28	8.56
Middle of the lake	8.21	8.48	8.50	8.09	8.32	8.48
Lake reservoir	8.27	8.48	8.64	8.34	8.43	8.64
Dam outlet	8.19	8.19	8.25	8.01	8.16	8.25

The average values of the pH were, in all studied periods and in all 4 sections taken into control of over 8, which indicates the alkaline nature of water from Stânca-Costești accumulation. The maximum value obtained was 8.64 during the period 09.08.2019 at the lake reservoir section.

Dissolved oxygen (DO)

Dissolved oxygen is a very important indicator of surface water quality and depends on a number of factors such as: water temperature, atmospheric pressure, depth, water turbidity and the amount of decomposing organic matter. Analyzing the water quality from Stânca Costești accumulation, in terms of dissolved oxygen we find that it falls within the IInd quality class (table 2).

Table 2. Dissolved oxygen values in the 4 sampling points (mg O_2/l)

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	8.20	7.70	5.90	5.33	6.78	8.20
Middle of the lake	7.90	7.60	6.70	6.44	7.16	7.90
Lake reservoir	7.90	6.90	5.80	7.00	6.90	7.90
Dam outlet	7.40	6.10	5.00	5.80	7.21	7.40

From the analysis of the data presented in table 2, we find that the lowest values for dissolved oxygen were recorded in the first two sampling points in September, when the values of this parameter were 5.33 mg O_2/l at Manoleasa Village and 6.44 mg O_2/l in the middle of the lake. For the other two sampling points the minimum values were recorded in August and were 5.00 mg O_2/l at the dam outlet and 5.80 mg O_2/l respectively at the lake dam.

According to season, the dissolved oxygen content in water changes depending on the air temperature, thus the highest oxygen content is recorded in the cold season, because the low temperatures reduce the oxidation and favor the dissolution of atmospheric oxygen in the water. (Păsărin, 2007). The values obtained by us in the case of dissolved oxygen are in accordance with those obtained by Vartolomei (2009), as a result of the analysis of the water quality of Stânca-Costesti accumulation, values that ranged between 6.8 and 10.2 mg O_2/l.

Biochemical oxygen demand (BOD)

The biochemical oxygen demand varies directly in proportion to the amount of organic substances contained in the water and is influenced by the action of the reducing chemical compounds (Dughilă, 2010, Lazu et al., 2019a, Lazu et al., 2019b).

Biochemical oxygen demand represents the amount of oxygen consumed for oxidative degradation by microorganisms of the contained organic substances, at standard temperature (20ºC) and standard time (5 days) in accordance with STAS 6560-82 and SR ISO 6060/96 or SR EN 1899-2/2002 (table 3).

Table 3. The Biochemical oxygen demand values in the 4 sampling points (mg O_2/l)

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	5.32	4.54	4.91	3.32	4.52	5.32
Middle of the lake	6.72	3.17	3.05	2.20	3.78	6.72
Lake reservoir	3.16	4.80	3.11	2.15	3.30	4.80
Dam outlet	2.86	3.42	2.02	2.10	2.60	3.42

Biochemical oxygen demand (B.O.D.) in Stânca-Costești accumulation ranged between 2.02 mg O_2/l, in August and 6.72 mg O_2/l in May, with average values oscillated between 2.60 and 4.52 mg O_2/l.

Nitrites (NO_2^-) – are intermediates produced as a result of oxidation of ammonia or reduction of nitrates by bacterial processes (ammonia, under the action of *Nitromonas* and *Nitrobacter* bacteria, in the presence of oxygen gradually transforms into nitrites, then into nitrates) (Bucureșteanu et al., 2008). The nitrogen content in the form of nitrogen ions was determined accordingly to STAS 8900/2-71 and SR ISO 6777-96.

The nitrites were reported in extremely small quantities (Table 4), their average values being between 0.02 0.03 (mg N/l).

Table 4. Nitrites values in the 4 sampling points (mg N/l)

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	0.03	0.03	0.06	0.01	0.03	0.06
Middle of the lake	0.03	0.02	0.01	0.01	0.02	0.03
Lake reservoir	0.02	0.02	0.02	0.01	0.02	0.02
Dam outlet	0.02	0.02	0.02	0.01	0.02	0.02

The nitrogen content of the water from the Stânca-Costești accumulation recorded in the 4 sampling points showed values that were in the range 0.01-0.06 mg N/l for the Manoleasa Village sampling point, between 0.01 and 0.03 mg N/l for the sampling point located in the middle of the lake, between 0.01 and 0.02 mg N/l for the lake reservoir sampling point, respectively between 0.01 and 0.02 mg N/l for the dam outlet sampling point.

Nitrates (NO_3^-) – represents an advanced stage of ammonium oxidation or is formed directly from molecular nitrogen. Thus, in the water of Stanca-Costești accumulation the main sources of nitrates are represented by the decomposition of organic waste and less by the use of nitrogen fertilizers in agriculture.

The nitrogen content in the form of nitrogen ions was determined accordingly to STAS 8900/1-71 and SR ISO 7890/1-98 (Table 5).

Table 5. Nitrates values in the 4 sampling points (mg N/l)

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	4.10	1.92	2.90	1.95	2.71	4.10
Middle of the lake	3.63	2.81	1.37	1.85	2.41	3.63
Lake reservoir	3.57	2.81	1.40	1.00	2.19	3.57
Dam outlet	3.95	3.00	1.80	1.05	2.45	3.00

The nitrate content recorded during the 4 months taken in the study, shows a decrease of this parameter during the warm period, more precisely in September 2019, when the values recorded at the 4 sampling points did not exceed 2.00 mg N/l, mainly due to the biogenic processes, which intensifies due to the high water temperature.

Chlorides (Cl^-) - the chlorine content in the water from Stanca-Costești accumulation was determined in accordance with STAS 8663-70 (Table 6).

Table 6. Chlorine values in the 4 sampling points (mg/l)

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	24.00	22.85	24.50	22.15	23.38	24.50
Middle of the lake	21.50	21.00	22.10	20.90	21.38	22.10
Lake reservoir	22.40	22.10	23.20	21.50	22.30	23.20
Dam outlet	25.30	21.30	23.30	21.60	22.88	25.30

The values obtained in the 4 sampling points in the case of chlorine content ranged between 21.50 and 25.30 mg/l in May, between 21.00 and 22.85 mg/l in June, between 22.10 and 24.50 mg/l in August, respectively between 20.90 and 22.15 mg/l in September.

The average values obtained allow the classification of water from Stanca-Costești accumulation in the 1st class of quality.

Sulphates (SO_4^{2-}) - the sulphate content of the water from Stânca-Costești accumulation was determined in accordance with STAS 8601-70 (Table 7).

Table 7. Sulphates values in the 4 sampling points (mg/l)

Sampling point	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Manoleasa Village	55.60	54.50	44.40	48.80	50.83	55.60
Middle of the lake	74.40	61.40	47.80	49.10	58.18	74.40
Lake reservoir	70.10	68.70	48.70	50.60	59.53	70.10
Dam outlet	78.70	61.70	41.70	45.80	56.98	78.70

The values for this indicator oscillated between 41.70 mg/l, as recorded in August and 78.70 mg/l, the value recorded in May both values being recorded at the same sampling point located at the dam outlet.
The average values (50.83-59.83 mg/l) allow the classification of water from Stanca-Costeşti accumulation in the 1st class of quality.

The main specific (toxic) chemical indicators that were analyzed were the ions of cadmium (Cd^{2+}), lead (Pb^{2+}), nickel (Ni^{2+}), copper (Cu^{2+}), zinc (Zn^{2+}) and chromium (Cr^{3+} and Cr^{6+}).
The average concentrations were calculated for the values recorded in the 4 monitoring periods and presented in table 8.

Tabelul 8. Heavy metal values in the 4 sampling periods (µg/l)

Hevy metals	15.05.2019	18.06.2019	09.08.2019	10.09.2019	Mean	Maximum
Cd total (µg/l)	0.07	0.07	0.07	0.05	0.06	0.07
Pb total (µg/l)	1.08	1.19	3.58	1.07	1.73	3.58
Ni total (µg/l)	7.66	2.50	0.99	5.49	4.16	7.66
Cu total (µg/l)	2.18	1.01	2.98	1.81	1.99	2.98
Zn total (µg/l)	7.24	9.13	4.35	1.40	5.53	9.13
Cr total (µg/l)	1.94	0.82	3.31	1.59	1.91	3.31

Analyzes for the determination of heavy metals were performed using modern methods of spectrometry and atomic absorption spectrophotometry.
The heavy metal concentrations determined ranged from 0.05 to 0.07 µg/l for cadmium, between 1.08 and 3.58 µg/l for lead, between 0.99 and 7.66 µg/l for nickel, between 1.01 and 2.98 µg/l for copper, between 1.40 and 9.13 µg/l for zinc, respectively between 0.82 and 3.31 µg/l for chromium. None of the heavy metals analyzed exceeded the maximum allowable concentration for first class of quality.

CONCLUSIONS

The average values of the pH, were, in all studied periods and in all 4 sections taken into control of over 8, which indicates the alkaline nature of water from Stânca-Costeşti accumulation.
Analyzing the water quality from the Stânca-Costeşti accumulation through the prism of dissolved oxygen (average values over the entire analyzed period between 6.78 and 7.21 mg O_2/l) we find that it falls in the second class of quality.
The sulphate content of the Stânca-Costeşti accumulation water had average values between 50.83-59.83 mg/l, which allows the classification in the 1st class of quality.
The average concentrations of analyzed heavy metals are below maximum permissible concentration for first class of quality.
As a general conclusion based on these results, we can say that water from Stânca-Costeşti accumulation fall within the II class of quality in terms of the dissolved oxygen and in the first class of quality in terms of nutrients, salinity and heavy metals.

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