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Monitoring Olt River Water Quality in Upstream and Downstream Miercurea Ciuc Town. Note II: The Interactions between the Monitored Physico-Chemical Indicators

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Abstract

The history of water on our planet likely begins 4.5 billion years ago with the formation of Earth, as water is an indispensable substance for life in any form. This study aims to identify the interactions among the physico-chemical parameters of water in the monitored section of the Olt River. Seven sampling points were established along the river, monitored in 2024, both upstream and downstream of Miercurea Ciuc municipality. To analyze the interactions among the identified physico-chemical parameters, their values were quantified, and simple Pearson correlations were calculated using STATISTICA for Windows, version 8.0. A moderate positive correlation between pH and conductivity was observed at most monitoring points, indicating that pH is influenced differently by the salt content of the water, with higher pH levels generally corresponding to increased conductivity. In contrast, turbidity showed an inverse relationship with pH, suggesting that pH is more strongly affected by the content and nature of impurities in the water. A positive correlation was also found between pH and calcium carbonate ($CaCO_3$) concentrations, revealing that higher calcium ion levels in the water have a significant impact on pH. Conductivity exhibited medium to very strong positive correlations with $CaCO_3$ concentrations, suggesting that it significantly affects the water's conductivity. Meanwhile, the relationship between turbidity and $CaCO_3$ concentrations was weak to moderate, indicating a relatively minor influence of calcium carbonate on the water's turbidity.

Keywords: calcium ions, correlations conductivity, pH, turbidity.

1. Introduction

The history of water on our planet probably begins 4.5 billion years ago with the formation of the earth, being an absolutely indispensable substance for life, regardless of its form. Water is also used as a raw material, as a means of cooling and heating, in the processes of dissolution, recrystallization, purification, distillation, hydrolysis and as a reaction medium [4, 7, 10].

The geographical units of the hydrosphere, respectively the territorial systems in which water is organized, are: oceans, seas, running waters, glaciers, lakes and groundwater [7, 10].

However, water is also a component of other layers of the Earth, with which the hydrosphere itself is in a permanent exchange/circuit. This is water from the atmosphere (in the form of vapor), from the biosphere (80% of living matter is composed of water), from the rocks of the crust (as free or chemically bound water) and from the soil. Over 71% of the Earth's surface is covered by water, which is unevenly distributed on Earth.

A large part of the Earth's water (97%) is found in seas and oceans, 2% in glaciers and less than 1% in rivers, lakes and groundwater [6, 10].

The Integrated Water Monitoring System (IWMS) in Romania is a complex set of activities and technologies dedicated to the monitoring, assessment and management of water resources in the country.

This system has the role of ensuring the systematic collection of data on water quality and quantity, contributing to environmental protection and sustainable management of water resources [2, 9, 11, 12]. The objectives of water quality monitoring can be general in nature, when monitoring is carried out without setting too detailed objectives [8].

The establishment of objectives starts from issues related to the place where the monitoring will be carried out, the purpose of the monitoring, the nature of the information to be obtained through monitoring (basic information, information for planning, operational or management information, for the development of standards or for the detection of pollution sources), the nature of the variables to be measured, the human and financial resources for monitoring, the way in which the monitoring information will be used.

The general objectives of water quality monitoring can be formulated as follows [8]:

- verifying that water intended for human consumption complies with quality standards and does not contain contaminants harmful to health.;
- developing an information support necessary to substantiate decisions in water management on the principles of sustainable development;
- creating a database necessary to comply with national and international legislation;
- informing the population about the state of water bodies.

Typical objectives of water quality monitoring include: detecting any sign of deterioration of water and its quality, identifying those water masses in the ecosystem that do not meet the pre-established conditions and standards regarding water quality, identifying contaminated areas, estimating the pollutant load taken up by the ecosystem or subsystem; determining the extent and effects of certain waste discharges, evaluating the effectiveness of a water quality management intervention [1, 5, 6].

The aim of the study is to identify the interactions between the physico-chemical parameters of water monitored on the studied section of the Olt River.

2. Material and Method

To achieve the objectives of the presented study, seven sampling points were established on the Olt River, in the period April - June 2024 upstream and downstream of Miercurea Ciuc municipality: P1- source, P2- Bălan, P3- Dănești, P4 - Miercurea Ciuc upstream, P5 - Miercurea Ciuc downstream, P6 – Sînsimion, and P7- Tușnad [3].

The monitoring activity was performed in spring of 2024 on Olt River upstream and downstream Miercurea Ciuc municipality, while turbidity, conductivity, pH, and calcium ions as $CaCO_3$, were the considered indicators. In order to identify the interactions between the above mentioned physico-chemical indicators on the studied section of the Olt River, after their quantification [3] were calculated the simple Pearson correlations, using STATISTICA for Windows, v. 8.0.

3. Results and Discusions

The pH is positively and moderately correlated with the conductivity values in most of the monitoring points. At the spring, however, although positive, the correlation is weak (R = 0.234), and at the monitoring point corresponding to the Tușnad locality it is moderately to strongly correlated (R = 0.685). This suggests that the pH is influenced differently by the salt content of the water depending on its specificities, mainly the metals/non-metals present, and an increase in pH is accompanied by an increase in conductivity (Table 1). Turbidity evolves in the opposite direction to pH, according to the values of the correlation coefficients calculated between the two indicators. In most sampling points, the correlations are average, and in the water sampled from the spring the correlation is weak to average. Similar to the results presented for the correlations between pH and conductivity, in the monitoring point corresponding to the Tușnad locality the correlation is average to strong equal to R = 0.684 (Table 2). This suggests that pH is influenced to a greater extent by the impurity content of the water depending on their specificity (Table 2).

Positive correlations are recorded between the averages of pH and those of $CaCO_3$ concentrations (mg/L), according to the values of the correlation coefficients calculated between the two indicators (Table 3).

Table 1. The simple correlations between the pH values (pH units) and conductivity (µS/cm) in collecting points

Variable	Turbid.1	Turbid.2	Turbid.3	Turbid.4	Turbid.5	Turbid.6	Turbid.7
pH1	0.234	-0.037	0.147	0.160	-0.013	-0.026	0.133
pH2	-0.001	0.567	-0.023	-0.040	-0.058	0.102	0.160
pH3	0.196	0.189	0.468	-0.064	0.100	-0.008	-0.044
pH4	0.175	0.145	-0.060	0.526	0.139	0.169	-0.047
pH5	-0.058	0.108	-0064	-0.060	0.606	0.086	-0.053
pH6	-0.098	-0.054	-0.049	-0.048	-0.059	0.544	0.116
pH7	-0.050	-0.068	0.195	0.201	-0.002	0.226	0.685

1 – upstream source; 2 – upstream of Bălan locality; 3 – upstream of Dănești locality; 4 – upstream of Miercurea Ciuc municipality; 5 – downstream of Miercurea Ciuc; 6 – downstream of Sînsimion locality; 7 – downstream of Tușnad locality.

Table 2. The simple correlations between the pH values (pH units) and turbidity (NTU) in collecting points

Variable	Turbid.1	Turbid.2	Turbid.3	Turbid.4	Turbid.5	Turbid.6	Turbid.7
pH1	-0.320	0.010	0.091	-0.002	-0.049	-0.074	-0.074
pH2	-0.077	-0.562	-0.021	-0.044	-0.017	-0.014	-0.004
pH3	0.059	0.064	-0.535	0.134	0.112	0.018	0.028
pH4	0.191	0.188	-0.007	-0,566	0.111	0.042	0.051
pH5	0.141	0.143	-0.001	0.066	-0.506	0.104	0.171
pH6	-0.057	-0.184	-0.032	-0.004	-0.124	-0.530	-0.099
pH7	-0.076	-0.033	-0.087	-0.094	-0.089	-0.007	-0.684

1 – upstream sourcee; 2 – upstream of Bălan locality; 3 – upstream of Dănești locality; 4 – upstream of Miercurea Ciuc municipality; 5 – downstream of Miercurea Ciuc; 6 – downstream of Sînsimion locality; 7 – downstream of Tușnad locality.

Table 3. The simple correlations between the pH values (pH units) and $CaCO_3$ (mg/L) content in collecting points

Variable	$CaCO_3$1	$CaCO_3$2	$CaCO_3$3	$CaCO_3$4	$CaCO_3$5	$CaCO_3$6	$CaCO_3$7
pH1	0.631	0.045	0.073	0.039	0.118	0.031	-0.055
pH2	-0.092	0.762	0.075	0.067	0.067	0.032	0.090
pH3	0.008	0.005	0.601	0.042	0.008	0.049	0.152
pH4	0.037	0.071	0.034	0.621	-0.006	0.020	0.005
pH5	-0.014	0.045	0.056	0.032	0.780	0.030	0.042
pH6	-0.010	0.013	0.006	0.019	0.021	0.631	0.014
pH7	-0.010	-0.035	-0.084	-0.076	0.017	-0.073	0.608

1 – upstream source; 2 – upstream of Bălan locality; 3 – upstream of Dănești locality; 4 – upstream of Miercurea Ciuc municipality; 5 – downstream of Miercurea Ciuc; 6 – downstream of Sînsimion locality; 7 – downstream of Tușnad locality.

In most sampling points the correlations are medium, but in the sampling points located in the vicinity of the Bălan locality and downstream of the Miercurea Ciuc municipality the strongest correlations are reported equal to R = 0.731 and, respectively, R = 0.780. This suggests that the pH is influenced to a greater extent by the higher calcium ion content of the water (Table 3).

The conductivity of the Olt River water on the monitored sections and the $CaCO_3$ concentrations (mg/L) are positively correlated medium, strong and very strong, according to the values of the correlation coefficients calculated between these two indicators. In most sampling points the correlations fall into the category of strong and very strong. Strong correlations correspond to sampling points located in the vicinity of the Bălan locality, but in the sampling points located in the vicinity of the Bălan locality (R = 0.753), upstream (R = 0.752) and downstream of the Miercurea Ciuc municipality equal to R = 0.798 and in the vicinity of the Sînsimion locality equal to R = 0.720. This suggests that there is an influence of the calcium carbonate content on the conductivity of the water (Table 4).

The turbidity of the Olt River water on the monitored sections and the $CaCO_3$ concentrations (mg/L) are positively correlated weakly and weakly to medium, according to the values of the correlation coefficients calculated between these two indicators. In most of the sampling points the correlations fall into the category of weak ones. Weak to medium correlations correspond to the sampling points located downstream of the municipality of Miercurea Ciuc equal to R = 0.312

and in the vicinity of the locality of Sînsimion equal to R = 0.363.This suggests the low influence of calcium carbonate content on water turbidity (Table 5).

Table 4. The simple correlations between the conductivity values (μS/cm) and conductivity (μS/cm) in collecting points

Variable	$CaCO_3$1	$CaCO_3$2	$CaCO_3$3	$CaCO_3$4	$CaCO_3$5	$CaCO_3$6	$CaCO_3$7
Cond. 1	0.664	-0.202	-0.057	-0.032	-0.029	-0.041	-0.034
Cond. 2	0.111	0.753	-0.031	-0.039	-0.012	-0.074	0.121
Cond. 3	-0.011	0.095	0.669	0.121	0.188	0.189	0.088
Cond. 4	-0.070	0.040	0.119	0.752	0.143	0.164	0.100
Cond. 5	0.131	-0.073	-0.074	-0.050	0.798	-0.022	0.050
Cond. 6	-0.168	0.167	0.106	0.129	0.191	0.720	0.138
Cond. 7	-0.072	0.118	0.116	0.184	0.146	0.183	0.680

1 – upstream source; 2 – upstream of Bălan locality; 3 – upstream of Dăneşti locality; 4 – upstream of Miercurea Ciuc municipality; 5 – downstream of Miercurea Ciuc; 6 – downstream of Sînsimion locality; 7 – downstream of Tuşnad locality.

Table 5. The simple correlations between the turbidity values (NTU) and conductivity (μS/cm) in collecting points

Variable	$CaCO_3$1	$CaCO_3$2	$CaCO_3$3	$CaCO_3$4	$CaCO_3$5	$CaCO_3$6	$CaCO_3$7
Turbid. 1	0.219	0.130	0.128	0.016	0.118	0.031	0.024
Turbid. 2	0.131	0.273	0.104	-0.015	-0.047	0.121	0.081
Turbid. 3	0.131	0.105	0.150	0.169	-0.062	0.024	-0.064
Turbid. 4	-0.084	0.091	0.157	0.246	0.089	0.043	0.113
Turbid. 5	0.160	-0.027	0.094	0.107	0,312	0.014	0.023
Turbid. 6	0.152	-0.027	0.053	0.042	-0.048	0.363	0.020
Turbid. 7	0.116	0.084	0.059	0.120	-0.022	0.036	0.213

1 – upstream source; 2 – upstream of Bălan locality; 3 – upstream of Dăneşti locality; 4 – upstream of Miercurea Ciuc municipality; 5 – downstream of Miercurea Ciuc; 6 – downstream of Sînsimion locality; 7 – downstream of Tuşnad locality.

4. Conclusions

The pH is positively and moderately correlated with the conductivity values in most monitoring points, which suggests that the pH is influenced differently by the salt content of the water depending on their specificities, mainly the metals/non-metals present, and an increase in pH is accompanied by an increase in conductivity.

Turbidity evolves in the opposite direction to pH, according to the values of the correlation coefficients calculated between the two indicators, suggesting that the pH is influenced to a greater extent by the impurity content of the water depending on their specificities.

Positive correlations are recorded between the averages of pH and those of $CaCO_3$ concentrations (mg/L), thus revealing that the pH is influenced to a greater extent by the highest calcium ion content of the water.

The conductivity of the Olt River water on the monitored sections and the $CaCO_3$ concentrations (mg/L) are positively correlated medium, strong and very strong, according to the values of the correlation coefficients calculated between these two indicators, which indicates that there is an influence of the calcium carbonate content on the water conductivity.

The turbidity of the Olt River water on the monitored sections and the $CaCO_3$ concentrations (mg/L) are positively correlated weakly and weakly towards medium, which suggests the low influence of the calcium carbonate content on the water turbidity.

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