

# Physicochemical of Water from the Tshopo River before Treatment, in Kisangani, RDC in 2024

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## Abstract

The physicochemical quality of the Tshopo River water before it enters the REGIDESO SA/Kisangani treatment plant in the Democratic Republic of Congo during the year 2024 was the subject of our research. The results show that the water quality of the Tshopo River does not differ significantly between quarters or between seasons in 2024, with p-values of 0.9647 and 0.9793, although there are noticeable differences between periods of heavy and dry rainfall. This is revealed by the results of analyses of more than seven physicochemical parameters, namely pH, turbidity, color, conductivity, temperature, oxidizable matter, and total alkalinity.

**Keywords:** Quality, Physicochemical, Treated water, Tshopo River.

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## 1. INTRODUCTION

Water is an essential and indispensable element for life (Samba N., 2026; Nabila, A. Z., 2025; Hamada I., 2025) and is used in various activities, such as irrigation, drinking water supply, industry, fishing, and others. This natural resource is therefore fundamental in terms of producing a sufficient food supply (Demard, H. 2009) and sustainable development in all regions of the world (Benamar A., 2020). Water on the Earth's surface is an essential part of the hydrological cycle. Water resources include surface water, groundwater, lakes, inland waters, rivers, coastal waters, and aquifers. It is a component of all living matter and constitutes an important tool for development. (Naminata N. *et al.*, 2022) It is also responsible for and indispensable in all biological and chemical activities (Yahmi Hanane and Zeroukhi, 2022). Three-quarters of the planet is covered in water (Nansi, G., 2025). There is only 2.6% freshwater on Earth; less than 1% is directly accessible. The recurring availability of data and information on water resources in general, and surface water in particular, contributes to better management of this resource (Dovonou F. *et al.*, 2023). The rest is in the form of ice. This water, used and polluted in nature, is becoming increasingly contaminated by pollutants generated by human activities (Simbu, A., *et al.*, 2022) and/or natural processes. Studies, particularly those provided by United

Nations agencies, are raising the alarm about the degradation of water resources (Bisimwa, A., *et al.*, 2022). One of the most recent is the one published by the World Bank in August 2019, entitled: "Unknown Quality: The Invisible Water Crisis" (Damania *et al.*, 2019). The fundamental problem of access to drinking water, according to SDG 6, stems from inadequate management worldwide, as well as from the ongoing pollution of water resources by industry, agriculture, and urban runoff (Khemis M, 2005). In most developing countries, surface waters are experiencing a significant decline in quality. Hence the need to assess the effect of treatments (Tfeila M *et al.*, 2016). Currently, due to population growth (Saab, H.B. *et al.*, 2007), rising living standards, agricultural development (fertilizers, mechanization), and industry, pollution from waste disposal has increased significantly and contributes to groundwater pollution (Alexis, *et al.*, 2019). Managing water resources requires stakeholders to have a thorough understanding of water quality and the various sources of pollution that can affect it (Hébert, S., 1997; Giroux, I., *et al.*, 2016). Water is one of the most important natural resources. Its availability can occasionally become a local issue (Poulin, *et al.*, 2024), and it is vital for all living organisms. Despite the fact that three-quarters of the planet is covered by water, the effectiveness (Nansi, G., 2022; Nansi, G., 2025) of drinking water distribution

services remains a concern, especially in developing countries. However, the benefits of improved drinking water supply are far from exhaustive; access to water contributes to improved hygiene and health for individuals, ecosystems, and humans, as well as to community health, food production, economic activities, and biodiversity. Water quality also influences human living standards (Kazadi Z, 2012). Given its importance in several areas of life, ensuring the physicochemical quality (Ernest K., 2022) of our river water is crucial for developing drinking water treatment frameworks (Simon B, 2018). Given the field of scientific research, this study aims to contribute to enriching the database of research conducted on water quality in general worldwide, and in Africa and the Democratic Republic of Congo in particular. Currently, in the city of Kisangani, the capital

of Tshopo province, the population uses water from the Tshopo River (Litumanya, 2012), treated by REGIDESO SA-Kisangani, for their daily needs. However, the physicochemical quality, based on even the minimum basic physicochemical parameters, remains a gap in the database for researchers and the public.

Therefore, this study aims to determine the water quality of the Tshopo River before it enters the treatment chain at the REGIDESO SA plant in Kisangani in 2024.

## 2. MATERIALS AND METHODS

### 2.1. Study Area



**Figure 1: Location of the sampling and analysis sites for water samples from the Tshopo River in Kisangani.**

The Kisangani region constituted the setting in which this work was carried out. The capital of Tshopo Province in the Democratic Republic of Congo (DRC), Kisangani is located at 0°31' North latitude and 25°11'4" East longitude. It is 428 meters above sea level (Nshimba, 2008).

### 2.2. Biological Material

Untreated and treated water from the Tshopo River.

### 2.3. Methodology

We collected six one-liter samples in glass beakers at 8:00 AM, spaced five to seven days apart each month, and analyzed immediately after collection for 12 months of the year 2024.

The physicochemical parameters evaluated on these samples, along with the analytical methods used, are: pH (pH meter, Brand: HANNA, Model: HI 2211), Conductivity (Conductimeter, Brand: HANNA, Model: HI 5321) by potentiometry (Spectrophotometer, Brand: HACN, Model: DR1900), Turbidity (Turbidimeter,

Brand: HANNA, Model: HI 88713-ISO), Color (Colorimeter, Brand: HANNA, Model: HI 96727), Temperature (thermometer), Oxidizable matter content (redox method), and Total Alkalinity (TAC) by titration.  $H_2SO_4$  0.1N), Total hardness (THt) by titration with  $K_2MnO_4$  0M), Nitrite ion ( $NO_2$ ) content by spectrophotometer (Method: Spectrophotometer), Chloride ions ( $Cl^-$ ) by argentimetry.

The preprocessing of the data obtained from the different analyses was subjected to the GraphPad outlier test to check for outliers, and the data was processed using MS Excel 16 and the ANOVA statistical test performed using PAST 2 Version 2.17b software.

## 3. RESULTS AND DISCUSSION

### 3.1. pH

The results of the water analysis of the Tshopo River, specifically the physicochemical parameter pH, are illustrated in Figure 1 below.

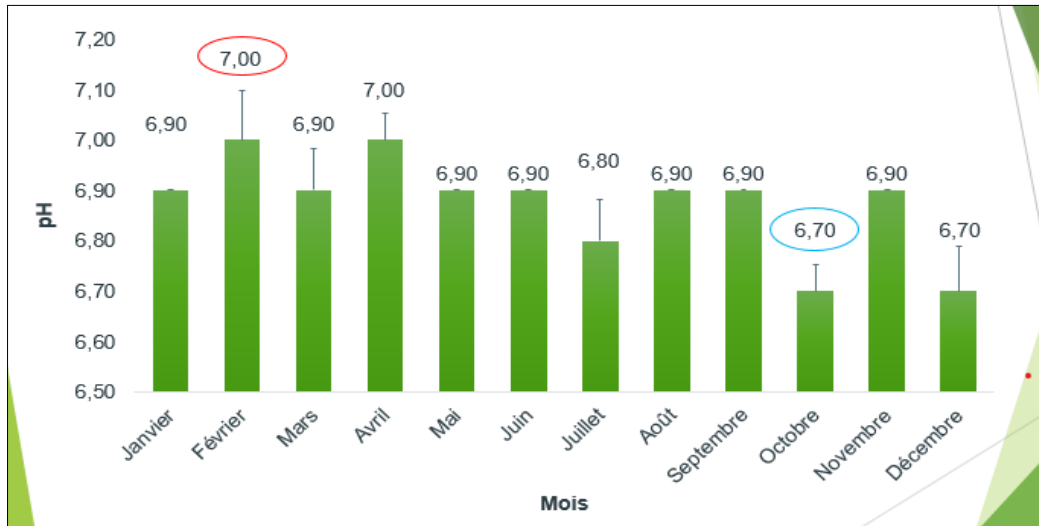


Figure 1: pH Graph

The pH values for February and April are higher (with average values of 7.0) compared to those for October and December (with average values of 6.7). It is noted that the pH values obtained are slightly acidic, unlike the pH value of 8.2 obtained by (Jérôme J, *et al.*, 2025).

### 3.2. Turbidity

The results of water analysis of the Tshopo River, specifically the physicochemical parameter turbidity, are illustrated in Figure 2 below.

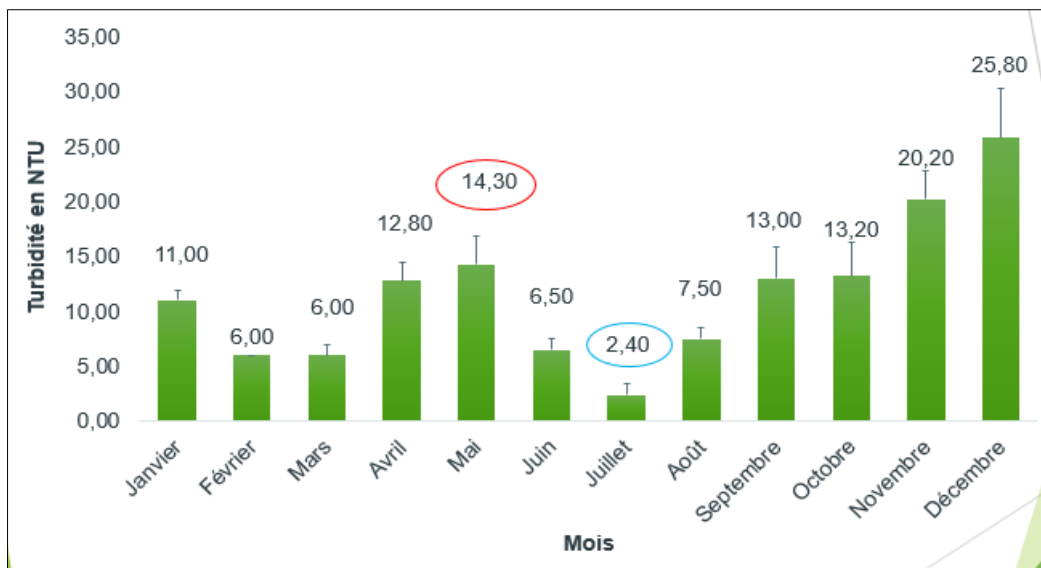


Figure 2: Turbidity Graph

The turbidity level in December was highest (with an average value of 25.80 NTU) compared to that of February, which was lower (with an average value of 2.40 NTU). Turbidity levels vary significantly between seasons during February and March, rising in April and May with peaks of 12.80 to 14.30 NTU, representing the dry season. Turbidity then falls again in June and July (6.50 to 2.40 NTU), coinciding with the short dry season (SDS). A further sharp increase is observed in

September, October, November, and December (13.00 to 25.80 NTU), characterizing the long rainy season (GRS), as reported by Tfeila, M. (2016).

### 3.3. Color

The results of the water analysis of the Tshopo River for the physicochemical parameter color are illustrated in Figure 3 below.

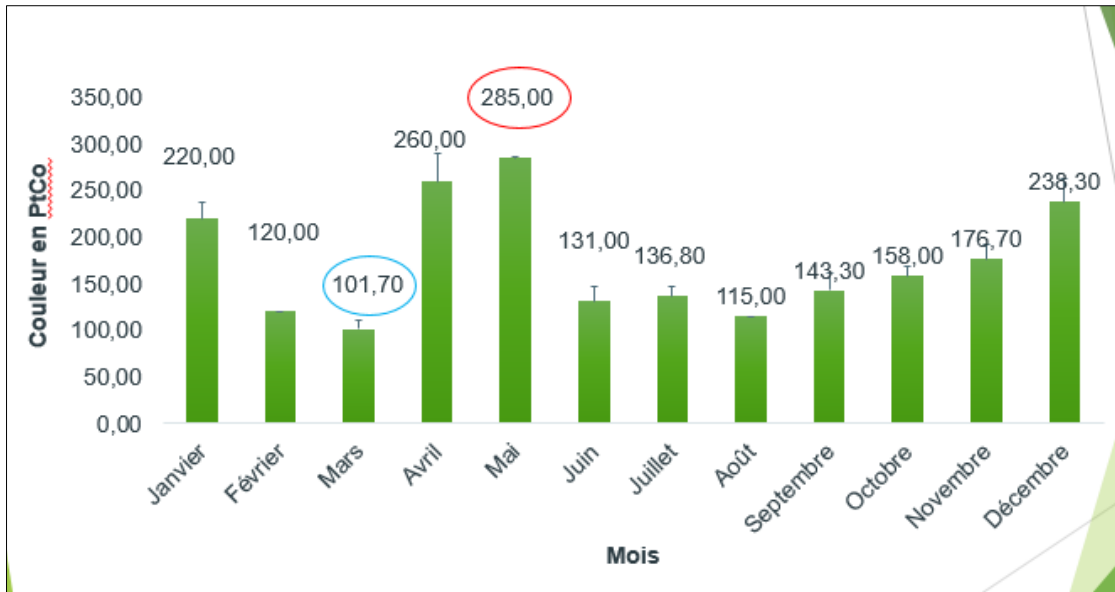


Figure 3: Color Graph

The color for the month of May is the highest (with an average value of 285.0 PtCO), compared to that for the month of March, which is lowest (with an average value of 101.7 PtCO).

### 3.4. Conductivity

The results of the water analysis of the Tshopo River for the physicochemical parameter conductivity are illustrated in Figure 4 below.

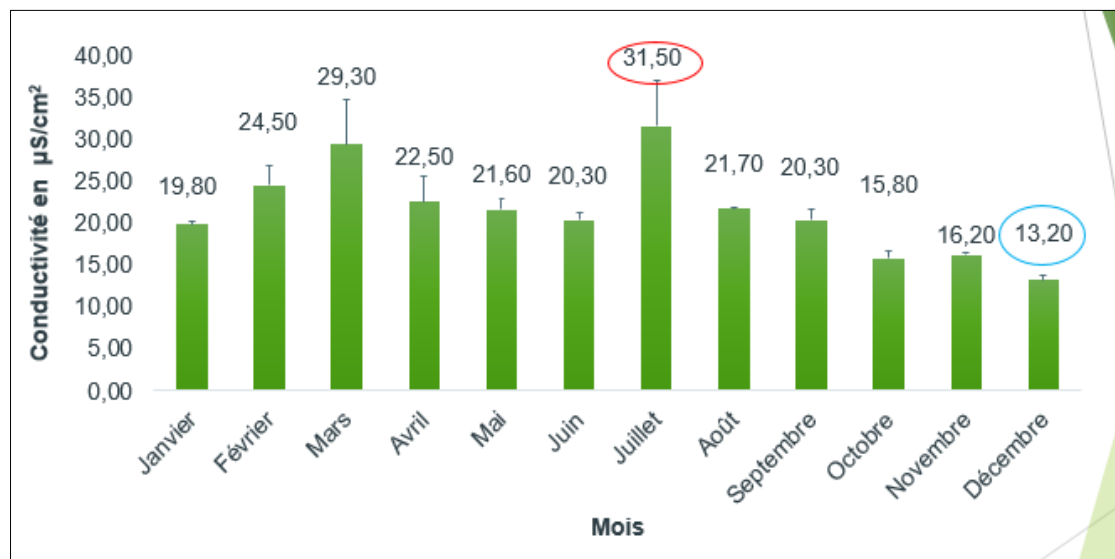


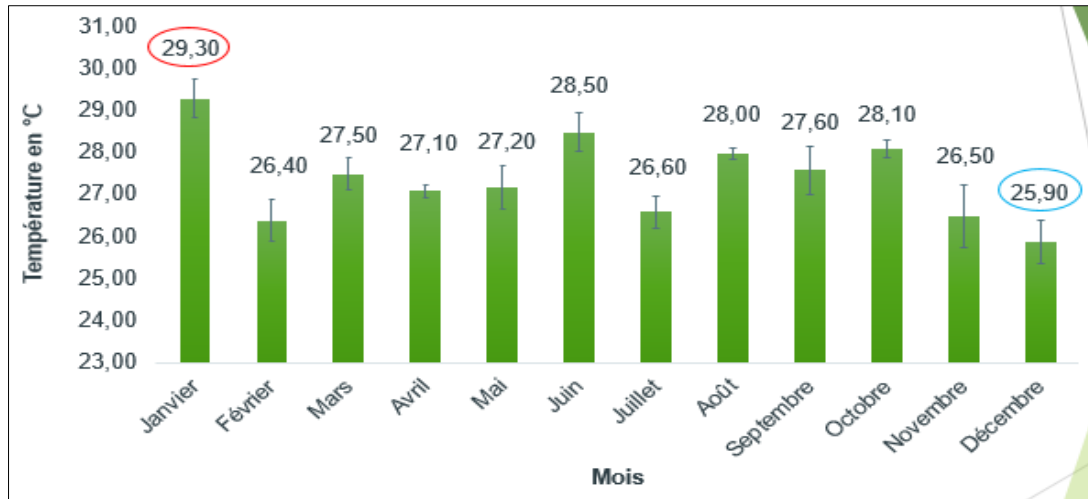
Figure 4: Conductivity Graph

The conductivity for the month of July is the highest (with an average value of 31.5 µS/cm<sup>3</sup>), compared to that for the month of December, which is lowest (with an average value of 13.2 µS/cm<sup>3</sup>). This is consistent with the findings of (Adje, D., *et al.*, 2019). These average electrical conductivity values for the water of the Tshopo River are lower than those of the Gombe River, which is higher mineral content, at 440.5 µS/cm and 355 µS/cm in the dry season and rainy season,

respectively, according to Akatumbila, L. *et al.*, (2016); and 271 µS/cm and 134 µS/cm in the rainy season, respectively, according to Rukahusa, R., *et al.*, (2022).

### 1.1. Temperature

The results of the water analysis of the Tshopo River for the physicochemical parameter temperature are illustrated in Figure 4 below.

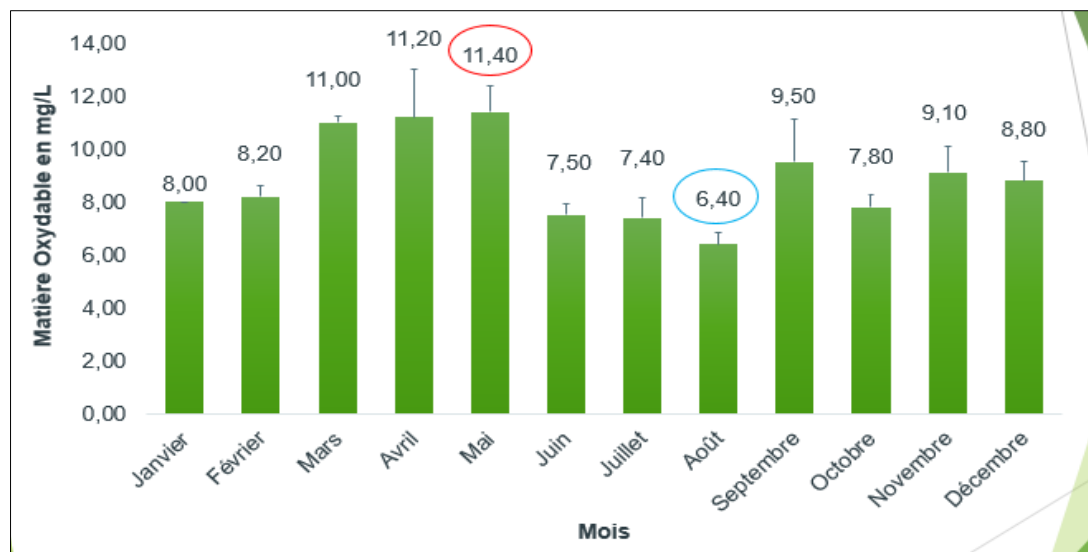


**Figure 5: Temperature Graph**

The temperature in January is the highest (with an average value of 29.30 °C), while that in December is lower (with an average value of 25.90 °C). These results accurately reflect the characteristic temperature of the climate. equatorial. The same trend was observed in the areas upstream of the dike by (Koji, E. *et al.*, 2022a) with the temperature varying from 24.1 to 29.8.

### 1.2. Oxidizable Matter

The results of water analysis of the Tshopo River for the physicochemical parameter of oxidizable matter are illustrated in Figure 6 below.



**Figure 6: Oxidizable Matter Graph**

The oxidizable matter values for the month of May are the highest (with an average value of 11.4 mg/L), compared to those for the month of August, which are lower (with an average value of 6.4 mg/L). (Benamar, A. *et al.*, (2020) in their work found low values ranging from 0.84 to 3.61 mg/L), and the same

trend is observed with the values obtained by (Abdoulaye, D., *et al.*, 2013)

### 1.3. Total Alkalinity

The results of the water analysis of the Tshopo River, specifically the physicochemical parameter of total alkalinity, are illustrated in Figure 7 below.



**Figure 7: Total Alkalinity Graph**

The total alkalinity for the month of August is low (with an average value of 0.8 °F) compared to those for the months of March and May, which are higher (with an average value of 1.5 °F) during the year 2024. Our values obtained are lower than those of Yao, T. *et al.*,

(2013) in their study on the chemical potability assessment of groundwater in a tropical watershed: the case of Southwest Côte d'Ivoire, who found an average of 10.8 °F.

**Table 1: Average Monthly Raw Water Results in 2024**

MOIS	JANVIER	FEVRIER	MARS	AVRIL	MAI	JUIN	JUILLET	AOÛT	SEPTEMBRE	OCTOBRE	NOVEMBRE	DÉCEMBRE
pH	6,9	7	6,9	7	6,9	6,9	6,8	6,9	6,9	6,7	6,9	6,7
Turbidité(NTU)	11	6	6	12,8	14,3	6,5	9,4	7,5	13	13,2	20,2	25,8
Couleur(PtCo)	220	120	101,7	260	285	131	133,5	115	143,3	158	176,7	238,3
Conductivité(µS/cm²S)	19,8	24,5	29,3	22,5	21,6	20,3	31,5	21,7	20,3	15,8	16,2	13,2
Température(t°)	29,3	26,4	27,5	27,1	27,2	28,5	26,6	28	27,6	28,1	26,5	25,9
MO(mg/l)	8	8,2	11	11,2	11,4	7,5	7,4	6,4	9,5	7,8	9,1	8,8
TAC(°F)	1,3	1,3	1,5	1,4	1,5	1,2	1,1	1,2	1,1	0,8	1	1

**Table 2: Average Quarterly Water Results Raw water in 2024**

	T1	T2	T3	T4
pH	6,9	6,9	6,9	6,8
Turbidité(NTU)	7,7	11,2	10	19,7
Couleur(PtCo)	147,2	225,3	130,6	191
Conductivité(µS/cm²)	24,5	21,5	24,5	15,1
Température(t°)	27,7	27,6	27,4	26,8
MO(mg/L)	9,1	10	7,8	8,6
TAC(°F)	1,4	1,4	1,1	0,9

**Legend:** T1 = Quarter 1; T2 = Quarter 2; T3 = Quarter 3; T4 = Quarter 4

The ANOVA test showed no significant difference in the physicochemical quality of these four quarters (with a p-value of 0.9647).

**Table 3: Average results per season/period of raw water in 2024**

	T1	T2	T3	T4
<b>pH</b>	6,9	6,9	6,9	6,8
<b>Turbidité(NTU)</b>	7,7	11,2	10	19,7
<b>Couleur(PtCo)</b>	147,2	225,3	130,6	191
<b>Conductivité(µS/cm<sup>2</sup>)</b>	24,5	21,5	24,5	15,1
<b>Température(t°)</b>	27,7	27,6	27,4	26,8
<b>MO(mg/L)</b>	9,1	10	7,8	8,6
<b>TAC(°F)</b>	1,4	1,4	1,1	0,9

**Legend:** SC = Dry Season 1; SP = Rainy Season; PSC = Short Dry Season; GSP = Long Rainy Season

The ANOVA test, This allowed us to observe that there is no significant difference in the physicochemical quality of these four seasons (with a p-value of 0.9793).

The physicochemical parameters determined according to our four seasons are pH (SC= 6.87; SP= 6.93; PSC= 6.85; GSP= 6.85), turbidity (SC=14.27 NTU; SP= 11.03 NTU; PSC= 7.95 NTU; GSP= 13.48 NTU), color (SC= 192.77 PtCo; SP=215.57 PtCo; PSC= 132.25 PtCo; GSP= 148.25 PtCo), conductivity (SC= 19.17 µS/cm; SP= 24.47 µS/cm; PSC= 25.90 µS/cm; GSP=18.80 µS/cm), and temperature (SC= 27.20 °C; SP=24.47 °C; PSC=27.55 °C; GSP=27.55 °C), oxidizable matter (SC= 8.33 mg/L; SP=11.20 mg/L; PSC= 7.45 mg/L; GSP= 8.20 mg/L), and total alkalinity (SC= 1.20 °F; SP= 1.47 °F; PSC= 1.15 °F; GSP= 1.13 °F). The differences observed between the dry and rainy seasons were not significant according to the ANOVA statistical test. The concentrations of the values obtained for the studied parameters indicate that the level of degradation of the Tshopo River water is low. (Koné, N., 2022)

## CONCLUSION

This scientific work aimed to study the physicochemical quality of the Tshopo River water during the year 2024. This was done with the goal of evaluating its behavior before it enters the REGIDESO SA/Kisangani treatment plant. It appears that the determined physico-chemical qualities of our four seasons or periods are as follows: pH (SC= 6.87; SP= 6.93; PSC= 6.85; GSP= 6.85), turbidity (SC=14.27 NTU; SP= 11.03 NTU; PSC= 7.95 NTU; GSP= 13.48 NTU), color (SC= 192.77 PtCo; SP=215.57 PtCo; PSC= 132.25 PtCo; GSP= 148.25 PtCo), conductivity (SC= 19.17 µS/cm; SP= 24.47 µS/cm; PSC= 25.90 µS/cm; GSP=18.80 µS/cm), temperature (SC= 27.20 °C; SP=24.47 °C; PSC=27.55 °C; GSP=27.55 °C), oxidizable matter (SC=8.33 mg/L; SP=11.20 mg/L; PSC=7.45 mg/L; GSP=8.20 mg/L), and total alkalinity (SC=1.20 °F; SP=1.47 °F; PSC=1.15 °F; GSP=1.13 °F). In light of these results, the physicochemical quality of the treated water will be the subject of our next

investigations to determine the impact of each season or period.

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