

Monitoring the Physico-Chemical Quality of the Davo River (South-West of Côte d'Ivoire)

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How to cite this paper: Aka, N., Gboko, Y.D.A., Keumean, K.N., Adjiri, O.A. and Soro, N. (2022) Monitoring the Physico-Chemical Quality of the Davo River (South-West of Côte d'Ivoire). *Open Journal of Applied Sciences*, 12, 1402-1415.
<https://doi.org/10.4236/ojapps.2022.128097>

Received: July 1, 2022

Accepted: August 22, 2022

Published: August 25, 2022

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Abstract

The Davo River, an affluent of the Sassandra River, like other rivers in Côte d'Ivoire, is subject to anthropogenic activities likely to deteriorate its quality which could affect its use as drinking water and also the health of aquatic organisms. This study aims at monitoring the temporal evolution of the physico-chemical quality of the waters of the Davo River at the Dakpadou hydro-metric station. Twelve monthly field missions were carried out to sample water, measure temperature, pH, Electrical Conductivity and analyse turbidity, Suspended solids, major elements (Cl^- , NO_3^- , HCO_3^- , SO_4^{2-} , Mg^{2+} , Ca^{2+} , Na^+ , and K^+) and Trace Metallic Elements (Hg, Fe, Cu, Cr, and Pb). Results show that the waters of the Davo river are poorly mineralized. They are also acidic during periods of low water and slightly basic during flooding periods. The average turbidity value of 10.18 NTU places these waters in the slightly turbid class. The waters have calcic bicarbonate facies during low water periods and sodium bicarbonate facies with low concentrations of major elements during flood months. The average TME concentrations of the Davo river indicate that the waters are not harmful for the health of the population and the aquatic environment.

Keywords

Davo River, Turbidity, Suspended Solids, Major Elements, Trace Metallic Element

1. Introduction

Freshwater is a natural resource essential for life support, environmental sys-

tems, and socio and economic development. However, water resources are facing major challenges such as climate variability, increasing water demand, conflicts of uses, pollution and availability and quality issues.

In Côte d'Ivoire, most of the surface waters are exposed to anthropogenic pollution from agricultural chemicals and uncontrolled domestic and industrial discharges [1] [2] [3]. The perceptible effects are the eutrophication of surface waters and the resurgence of water-related diseases. This pollution makes it expensive to treat this water for consumption [4]. For this reason, the drinking water supply is oriented toward the exploration of deep groundwater, which is generally within WHO international drinking water standards [5]. Only the aquifers of the sedimentary basin representing about 2.5% of the ivorian territory can provide significant flows for drinking water supply. For the remaining 97.5% of the territory composed of crystalline and crystallophyllous rocks [6], the ivorian authorities have to turn to surface waters to achieve the goal of the point 6 of the UNESCO Sustainable Development Goals. Several highly urbanized or upcoming localities are still supplied with water from rivers [7]. The Davo River basin drains several localities such as Gagnoa, Sinfra, Ouragahio, Guiberoua, Gueyo and Dakpadou. Because of its sustained flows, this river is of great interest and it can be used to supply water to the populations of these localities. However, data and informations on water quality on this basin are scarce and undocumented. The only known study [8] highlighted the analysis of the response as well as the endogenous adaptation measures of this basin to climate change and anthropogenic pressures. Besides, the waters of the Davo River could have been impacted by agriculture which is the major economic activity of this area. This study intends to monitor the physico-chemical quality of the waters of the Davo River. The results of this work will help to better understand the quality of the waters of this river for their possible use in drinking water supply and to guarantee their good ecological status. They could also contribute to the establishment of a management and development plan for this watercourse by decision-makers. An overview of the study area will precede the methodology used and the main results discussed before the conclusion of the study.

2. Methodology

2.1. Study Area Presentation

The Davo River is a left bank affluent of the Sassandra River. It's located in the southwest of Côte d'Ivoire. Its catchment area covers 7194 km² and lies between longitudes 6°47W and 5°69W and latitudes 6°85N and 5°03N (**Figure 1**).

The basin falls within the transitional equatorial (or "Attieen") climate. Precipitation distribution is as follows [9]: the main rainy season runs from April to mid-July, with a maximum centered on June; the short rainy season extends from mid-September to November and is marked by thunderstorms and squalls; the dry periods are marked by low precipitation from mid-July to mid-September (short dry season) and from December to February (main dry season). The Davo

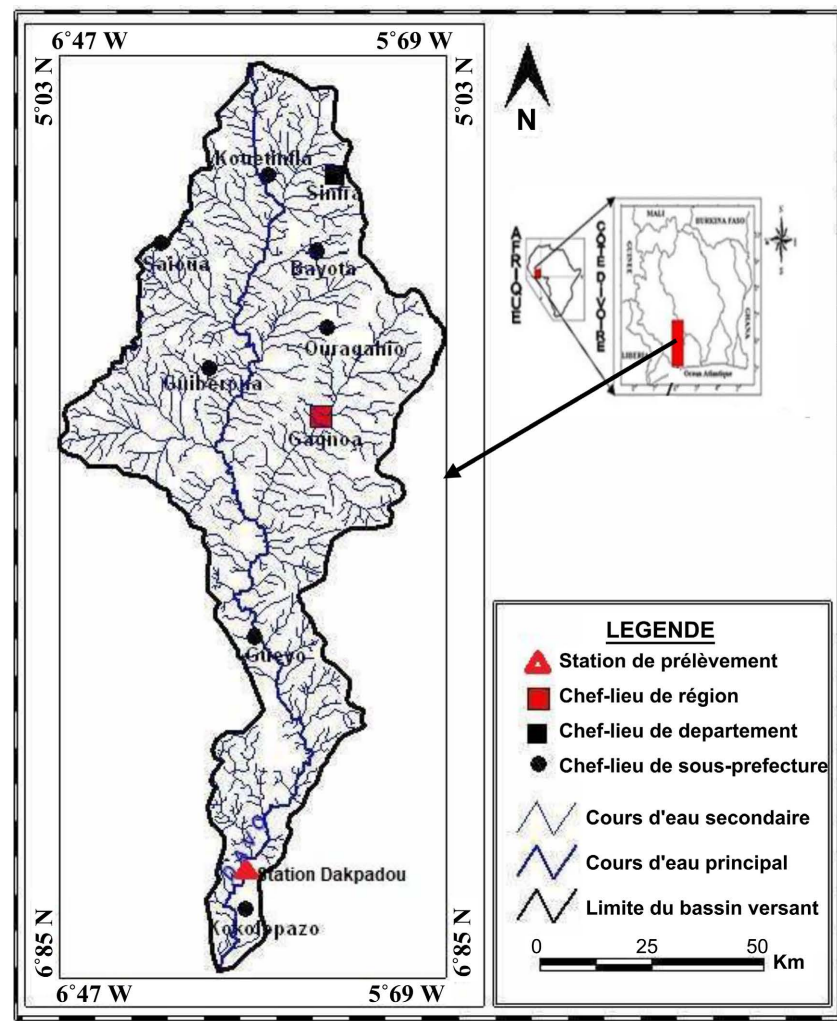


Figure 1. Davo River basin (modified from [8]).

basin is covered by dense forest-type vegetation belonging to the Guinean great rainforest, which has moderate water and atmospheric humidity requirements. This vegetation, which was formerly dominated by a large tropical forest, is today composed of small and isolated patches of forest [8]. The entire study area is composed of a slightly undulating peneplain, with an average altitude of 200 m and a slope of 1% inclined towards the sea. This basin is underlain by the basement of the old Precambrian shield, which is made up of migmatites, gneisses, amphibolo-pyroxenites, and various granitoids (two-mica granites, granodiorites), which are the fillers of the supergroup (schists, quartzites, rhyolites, basalts, and andesites). Other formations include the flyschoids which outcrop to the east of the Davo River tuffs. In addition, the basin is dominated by reworked soils: modal to indurated facies (granite) are located in the center; modal with overlying facies (granite) in the north and modal with indurated patches (shale) in the south of the basin. Hydromorphic soils are also found along the river. Soils on granite with patches and soils on green rocks are found in the south [8].

Figure 2 shows the average monthly flow distribution of the river at Dapkadou

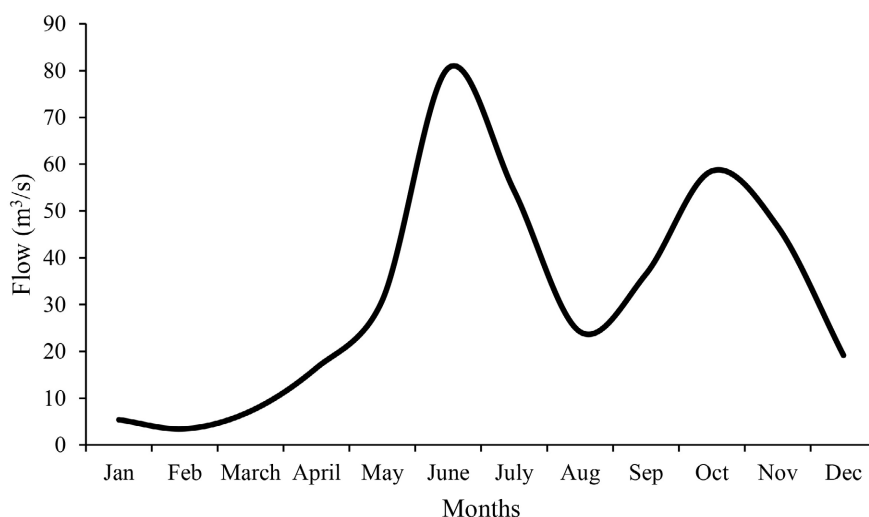


Figure 2. Hydrograph of the Davo River flows at Dapkadou over the period 1969-2004 [8].

station over the period 1969 to 2004. The interannual modulus of the Davo River calculated over this period is 32.11 m³/s.

2.2. Sampling Methods and Data Analysis

Monthly water sampling and measurements were carried out during a hydrological year from August 2019 to July 2020 at the Dakpadou hydrological station located downstream of the river. The parameters studied were temperature, pH, electrical conductivity (EC), major cations (Mg²⁺, Ca²⁺, Na⁺, and K⁺), major anions (Cl⁻, NO₃⁻, HCO₃⁻ and SO₄²⁻), Turbidity, Suspended Solids (SS) and five Trace Metal Elements (TME): Iron (Fe), Lead (Pb), Copper (Cu), Chromium (Cr) and Mercury (Hg). In-situ measurements of temperature, EC, and pH were performed using a HACH HQ 40D multiparameter. Then, two polyethylene bottle samples were collected for analysis. One bottle of 1 Litre for the anions and one of 50 mL for major cations and TME. 0.25 mL of nitric acid (HNO₃) were added to this sample as a preservative. The determination of the TME was done with a sample collected every 3 months. For the TSS and the turbidity, daily samples of 1 Litre which have been collected during the month were analysis after the field mission.

Sulfates (SO₄²⁻) and nitrates (NO₃⁻) were measured colorimetrically in the chemistry laboratory of the Ivorian Anti-Pollution Centre (CIAPOL) using a HACH DR 6000 spectrophotometer. Sulfates analyses were performed by using the Sulfaver 4 method. Nitrates were determined using cadmium reduction method. Chlorides (Cl⁻) and bicarbonates (HCO₃⁻) were determined volumetrically using a HACH digital titrator. Analysis of chlorides were performed with thiocyanate mercury method. Bicarbonates were determined indirectly from complete alkalimetric titre (TAC) since all samples pH were less than 8.3.

The major cations and TME were analysed using an Atomic Absorption Spectrometer (AAS) with specific wavelengths for each element at the Laboratoire

National d'Appui au Développement Agricole (LANADA) in Abidjan. Major cations, Iron (Fe) and copper (Cu) were determined using the oxidizing air-acetylene flame. Lead (Pb) and chromium (Fe) were determined using the AAS technique in the oven. Mercury (Hg) was determined using the hydride AAS technique.

Turbidity and TSS were analysed at the Centre de Recherches Oceanologiques (CRO) chemistry laboratory. Turbidity is defined as the reduction in transparency of a liquid resulting from the deposit of colloidal and/or suspended matter [10]. Suspended solids is defined by [11] as corresponding to particles of small size or low density that limit their fall by gravity in water. Hence, to some extent, turbidity includes both TSS and colloidal matter (0.2 and 0.45 μm). Turbidity was measured using a HACH 2100 QiS turbidimeter.

Suspended solids were determined using the gravimetric method which involved filtering water samples of 500 to 1000 mL through preweighed and dried Millipore 0.45 μm porosity membrane filter. The filters were later dried to constant weight at 105°C for 24 hours before weighing them again to determine TSS by difference. The suspended matter content is given by the following equation [12]:

$$\text{TSS} = \frac{M_2 - M_1}{V} \quad (1)$$

TSS: Suspended solids (mg/L); M_1 : Mass of the filter before filtration (mg); M_2 : Mass of the filter after filtration and drying (mg); V : Volume of filtered water (mL).

A multivariate statistical study analysis using Pearson correlation matrices from Statistica 7.0 software was used to highlight the contribution of TSS and turbidity to the transport of TME.

To assess the physico-chemical quality of the waters of the Davo river, the different values of the parameters studied will be compared with the guideline values proposed by the [13].

Graphical plots presented in this paper were prepared using Microsoft Excel.

3. Results

3.1. Physical Parameters and pH

The physical parameters and the pH values as well as their basic statistics are shown in **Table 1**. The monthly variations are shown in **Figure 3**.

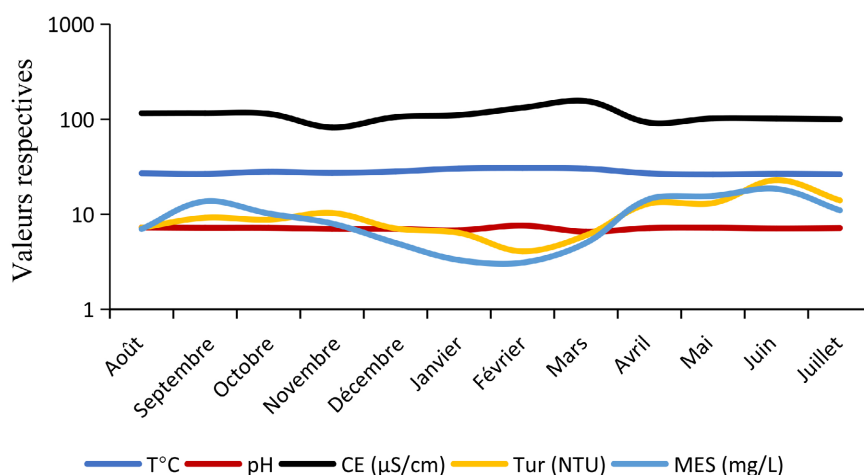
Temperature value ranged from 26.3°C to 30.7°C with an average of 27.8°C $\pm$ 1.63°C. The highest values corresponded generally to the months of low water level and the lowest values to the months of high water level.

pH values ranged from 6.56 to 7.60 with an average of 7.11 $\pm$ 0.26. In most cases, the pH values were neutral. Two acidic pH values were obtained in January (6.8) and March (6.56) during the low water period.

Electrical Conductivity fluctuated from 82 $\mu\text{S}/\text{cm}$ to 155.2 $\mu\text{S}/\text{cm}$ with an average of 110.5 $\pm$ 19.02 $\mu\text{S}/\text{cm}$. EC value were generally higher during the low water than those obtained during the high water period.

Table 1. Results of physical and pH parameters.

Month	T °C	pH	EC (µS/cm)	Turb (NTU)	TSS (mg/L)
August	27.0	7.26	115.6	7.22	7.0
September	26.6	7.20	115.9	9.20	13.7
October	28.0	7.20	114.0	8.78	10.2
November	27.2	7.02	82.0	10.32	8.0
December	28.2	7.01	105.3	7.10	5.0
January	30.3	6.80	110.6	6.37	3.3
February	30.7	7.60	132.2	4.08	3.1
March	30.2	6.56	155.2	6.00	5.0
April	26.9	7.17	92.0	13.01	14.5
May	26.3	7.23	102.0	13.12	15.6
June	26.7	7.10	101.5	22.88	18.5
July	26.4	7.17	100.0	14.00	11.0
Mean	27.8	7.11	110.5	10.18	9.6
Standard deviation	1.63	0.26	19.02	5.07	5.15
Min	26.3	6.56	82.0	4.08	3.1
Max	30.7	7.60	155.2	22.88	18.5
[13] Standards	-	6.5 - 8.5	-	5	15

**Figure 3.** Evolution of physical parameters and pH.

The average Turbidity (Turb) was 10.18 ± 5.07 NTU. The minimum value was obtained in February (4.08 NTU) and the maximum value obtained in June (22.88 NTU) during the high flood. All the other values are between 5 NTU and 30 NTU, placing these waters in the class of slightly turbid waters during these months.

SS ranged from 3.1 mg/L in February to 18.5 mg/L in June with a mean of 9.58 ± 5.15 mg/L. Standard deviations for temperature and pH are respectively 1.6

and 0.26. These values show that temperature and pH vary slightly over the year. Turbidity (5.07), SS (5.15) and EC (19.02) standard deviations values indicate that these parameters are not homogeneous throughout the year.

3.2. Major Ions

Table 2 shows the basic statistics of major elements concentrations in Davo River waters. **Figure 4** and **Figure 5** show the monthly evolution of these parameters over the study period.

Table 2. Basic statistics of the major element concentrations.

Parameters	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard deviation	[13] (mg/L)
NO_3^-	0	12.8	3.555	3.45	50
HCO_3^-	25.46	37.789	32.436	3.73	-
SO_4^{2-}	0	10	4.125	5.07	-
Cl^-	5.5	13.7	10.58	2.8	250*
Mg^{2+}	0.927	3.12	2.061	0.90	50*
Ca^{2+}	2.17	11.197	5.685	2.82	60 - 100*
K^+	0.884	6.182	2.693	1.53	-
Na^+	1.76	6.276	4.247	1.47	200*

*Values not based on health arguments.

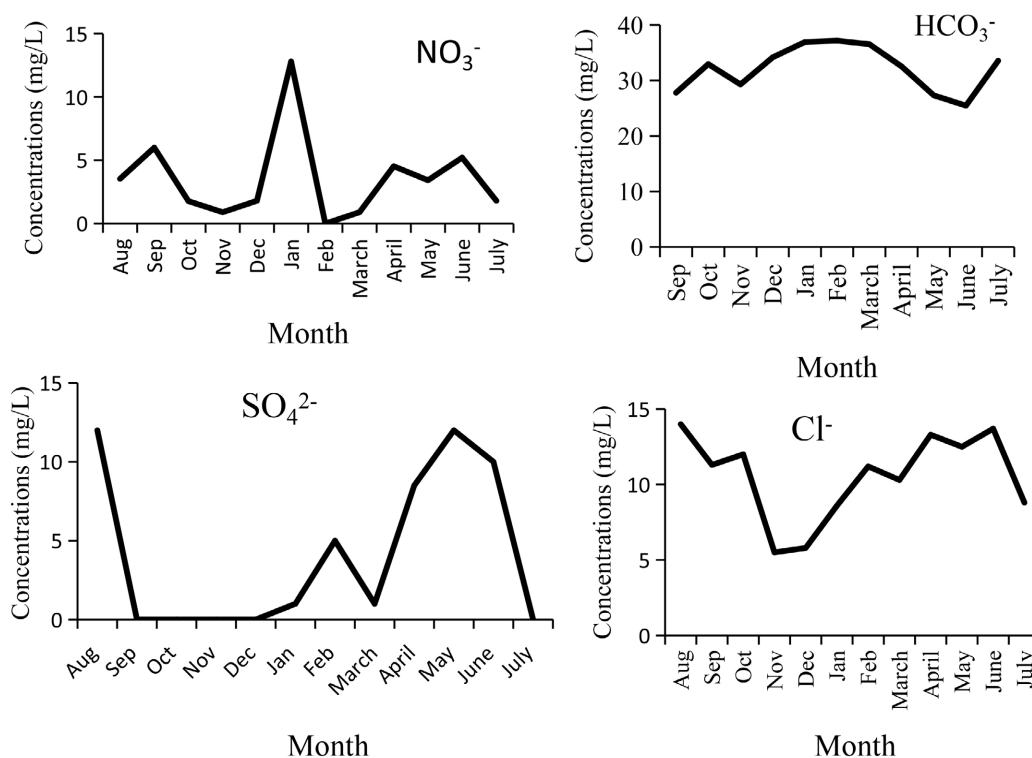


Figure 4. Monthly evolution of major anions concentrations.

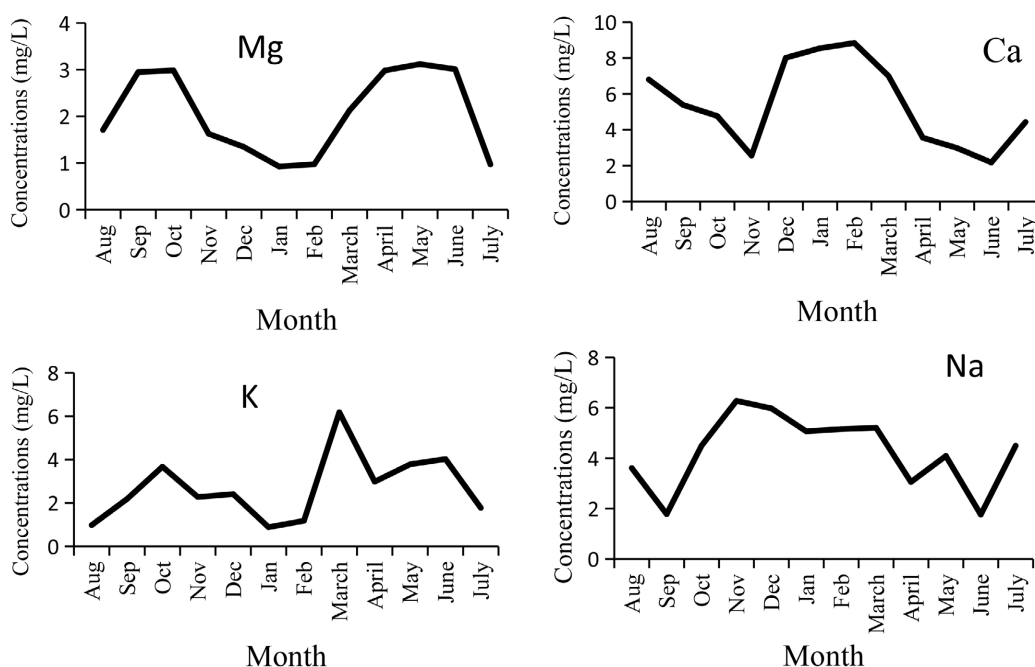


Figure 5. Monthly evolution of major cations concentrations.

Table 2 shows that nitrate (NO_3^-) concentrations ranged from 0 mg/L in February to 14 mg/L in January with an average of 3.55 ± 3.45 mg/L. These values are all far below the WHO standard. Bicarbonates (HCO_3^-) average concentration was 32.44 ± 3.73 mg/L, with minimum of 25.46 mg/L and maximum of 37.79 mg/L. Sulphate concentrations were 0 mg/L during 5 months (September, October, November, December, and July). The maximum concentration was 10 mg/L obtained in June (peak of the rainy season) and the average was 4.125 ± 5.07 mg/L. Chloride (Cl^-) concentrations ranged from 5.5 mg/L in November to 13.7 mg/L in June with an average of 10.58 ± 2.8 mg/L.

Cations concentrations were generally very low. Magnesium (Mg^{2+}) average concentration was 2.06 ± 0.90 mg/L with a minimum of 0.93 mg/L and a maximum of 3.12 mg/L. The calcium concentrations (Ca^{2+}) ranges between 2.17 mg/L and 11.20 mg/L with an average of 5.68 ± 2.80 mg/L. This cation was the most abundant one in the Davo River waters.

Potassium concentrations ranged from 0.88 mg/L in January to 6.182 mg/L in June with an average of 2.69 ± 1.53 mg/L. Sodium (Na^+) minimum concentration was obtained in June (1.76 mg/L) and the maximum in November (6.28 mg/L). The average concentration was 4.25 ± 1.47 mg/L.

3.3. Trace Metallic Elements (TME)

Table 3 shows the basic statistics of the TME concentrations. Iron (Fe) is the most abundant TME with concentrations ranging between 57 $\mu\text{g/L}$ and 490 $\mu\text{g/L}$ and an average of 210.25 $\mu\text{g/L}$.

Copper (Cu) concentrations varied from 2.039 $\mu\text{g/L}$ in February to 6.718 $\mu\text{g/L}$ in August with an average concentration of 4.517 $\mu\text{g/L}$. Chromium (Cr) average

concentration was 2.736 µg/L with a minimum of 0.475 µg/L and a maximum of 5.242 µg/L. Lead (Pb) average concentration was 1.56 µg/L. The minimum concentration was 0.006 µg/L. The maximum concentration, obtained during the short dry season was 3.882 µg/L. Mercury (Hg) concentrations ranged from 0 to 1.969 µg/L with an average of 1.403 µg/L.

3.4. Correlation between SS, Turbidity and TME Concentrations

Table 4 and **Table 5** show respectively Pearson correlation matrix between TSS and TME and turbidity and TME. Strong correlations were obtained between TSS and Fe (0.73), TSS and copper (0.66) and TSS and Cr (−0.87), while weaker correlation was observed with Pb (0.31). Positive strong correlations between turbidity and Fe and turbidity and Hg were obtained, which Pearson coefficients were respectively 0.99 (Fe) and 0.58 (Hg). Weaker correlations were observed between turbidity and Cu (0.05), Pb (−0.35) and Cr (−0.38).

Table 3. Basic statistics of TME concentrations (µg/L).

Parameters	Minimum	Maximum	Mean	[13] standards
Fe	57	490	210.25	300*
Cu	2.039	6.718	4.517	2000*
Cr	0.475	5.242	2.736	50
Pb	<0.006	3.882	1.56	10
Hg	<0.006	1.969	1.403	6

*Values not based on health arguments.

Table 4. Correlation matrix between SS and TME.

	SS	Fe	Pb	Cu	Cr	Hg
SS	1.000000					
Fe	0.730339	1.000000				
Pb	0.313240	−0.419937	1.000000			
Cu	0.667651	−0.020928	0.916143	1.000000		
Cr	−0.878573	−0.315409	−0.728775	−0.942147	1.000000	
Hg	−0.053003	0.643415	−0.964942	−0.778815	0.523503	1.000000

Table 5. Correlation matrix between turbidity and TME.

	Turb	Fe	Pb	Cu	Cr	Hg
Turb	1.000000					
Fe	0.997494	1.000000				
Pb	−0.354669	−0.419937	1.000000			
Cu	0.049866	−0.020928	0.916143	1.000000		
Cr	−0.381764	−0.315409	−0.728775	−0.942147	1.000000	
Hg	0.587637	0.643415	−0.964942	−0.778815	0.523503	1.000000

4. Discussion

Water temperature is an important factor in the aquatic environment as it controls almost all physical, chemical and biological reactions [14]. It also affects the density, viscosity, gases solubility and dissolved salts dissociation [12]. The monthly temperature values as well as the annual average are all higher than 15°C. Such temperature values favour growth of microorganisms and nuisance development, causing consequently water taste, colour and odour issues [13].

pH characterizes water acidity and alkalinity on a logarithmic scale from 0 to 14. Natural waters pH are related to the geological nature of the lands crossed. In this study, pH values ranged from 6.56 to 7.6 with an average of 7.11. These values are close to those obtained by [3] (6.53) in the N'zi River, by [15] (7.18) in the Comoé River, by [16] in the Agneby (6.48) and Me (6.65) rivers and by [17] (7.26) in the Sassandra River at Gaoulou. According to [13], although pH does not usually have a direct impact on consumers, it is one of the most important operational parameters of water quality. Careful attention must therefore be paid to pH regulating at all stages of water treatment to ensure proper clarification and disinfection. To minimize the risk of corrosion in domestic water supply lines, water pH must be regulated. [13] suggests a pH range of 6.5 to 8.5 for the protection of these pipes.

Electrical conductivity measures the overall mineralization of the aqueous solution. It depends on the salt contents in the solution. During salts dissolution they dissociate into pairs of ions (anions and cations) which allow an electric current to circulate. Therefore, the more the solution is mineralized the more ions it contains and the higher the electrical conductivity. Davo River water samples had electrical conductivity values ranging between 82 µS/cm and 155.2 µS/cm with an average of 110.5 µS/cm. These waters can be considered as low mineralized. This weak mineralization could be explained by the short contact time with the bedrock due to the water flow and influence of rainwaters, which are very weakly mineralized. Indeed, during the rainy season, most of the water input comes from surface to subsurface runoffs. Our results further showed that conductivity decreased with flood. Thus, the lowest value was obtained at the end of the flood in November (82 µS/cm) and the maximum value during low water during the month of March (155.2 µS/cm).

Furthermore, the TSS and turbidity values are also high during the flood period compared to those during the low flow period. This is due to the heavy rains observed during this period which lead to strong soil erosion in the vicinity of the river (soil leaching). The turbidity values are in the slightly turbid water class (5 NTU < turbidity < 30 NTU) and the average of 10.18 NTU is above the WHO guideline value of 5 NTU proposed for raw water intended for drinking. Regarding TSS, only the June concentration (18 mg/L) is higher than the WHO guideline value set at 15 mg/L. According to [18], the turbidity and TSS values lead to the Davo River waters to be classified as very good (2 NTU < turbidity < 15 NTU and SS < 5 mg/L) to good (15 NTU < turbidity < 30 NTU and SS < 25

mg/L).

Regarding ionic composition, the waters of the months of low water level have a calcium bicarbonate facies while those of the flood months have a sodium bicarbonate (November, May and July) or potassium (June) facies. With regard to anions, high concentrations of bicarbonates are observed during periods of declining water level and low concentrations during periods of flooding due to mixing with rainwater, which have low bicarbonate contents [19]. [20] described this same phenomenon in the waters of the Brimay, San-pedro and Nero, three southwestern rivers in Côte d'Ivoire having similar characteristics (climate, soils, vegetation, geology, etc.) to those of the Davo River. However, chloride (Cl^-) and sulphate (SO_4^{2-}) concentrations increased with the flood. This gradual increasing would be due to wastewater inputs and urban discharges for SO_4^{2-} ions and to atmospheric deposits for Cl^- ions. According to [12], which did not proposed health-based guideline values, Cl^- concentrations higher than 250 mg/L lead to undesirable taste to water and higher SO_4^{2-} contents could cause gastrointestinal ailments. High variability in NO_3^- concentrations were observed, but all these contents remain below the [12] guideline value which is 50 mg/L.

On the other hand, the metal cation inputs are insignificant in the waters of the Davo River. These contents would come from the highly desaturated ferrallitic soils of the basin for which the exchange capacity as well as the saturation rate (ratio of exchangeable cations to the total exchange capacity) is extremely low [20]. Ions Ca^{2+} showed the highest contents with an average of 5.41 mg/L followed by Na^+ (average of 4.2 mg/L). Calcium ions come from the dissolution of calcium carbonates in the aquifer in the presence of CO_2 . Carbonates dissociate into carbonic acids then into bicarbonates by releasing the calcium ion in the presence of CO_2 . However, [20] obtained Na^+ as the dominant cation in the three rivers of southwestern Côte d'Ivoire. According to this author, this would be a characteristic of acid soils on crystalline rocks where Na^+ ions are predominant. Ca^{2+} and Na^+ found in large part in the waters of the Davo River come mainly from groundwater, which could explain their increasing contents with the drop in water levels.

Unlike the other ions, Mg^{2+} and K^+ contents increase with the flood. This would be due to the use of fertilizers for agriculture.

[21] and [17] described similar concentrations of major anions and cations in the waters of the Sassandra River at its hydrometric station in Gaoulou.

With regard to the quality of the Davo river waters related to the studied TME, iron is by far the most abundant element with an average content of 210.25 $\mu\text{g/L}$. These high iron contents are a characteristic of the waters of Côte d'Ivoire [22]. [13] proposes for aesthetic reasons (metallic taste, stains in laundry) a non-binding upper limit of 300 $\mu\text{g/L}$ of iron for drinking water. The other metals show very low levels compared to the standards set by the [13].

The Pearson correlation matrices showed that Fe was strongly correlated with TSS (0.73) and turbidity (0.99), indicating transport in particulate and/or col-

loidal forms of Fe as observed by [23] [24]. This could be explained by the predominantly ferralitic soils in the study area. During the weathering process, sesquioxides Fe_2O_3 are released and accumulate on the surface by upward migration due to surface evaporation [20]. The rains when tearing off the terrigenous particles carry away the Fe in the form of ferrous oxide and reject them into the waters of the river. This could explain that high Fe concentrations were observed during flood periods with a maximum of 490 $\mu\text{g/L}$ in November while minimum concentrations were obtained during the long dry season (57 $\mu\text{g/L}$ in February). [20] also obtained similar result when studying the waters of the Sassandra river at the Gaoulou hydrometric station.

The correlations between Pb and Cu are greater with TSS than with turbidity. This would indicate that Pb and Cu in the waters of the Davo River are more bound to TSS, thus transported by particles larger than 0.45 μm [25]. Hg was moderately correlated with turbidity which includes colloidal particles of 0.2 to 0.45 μm size and negatively correlated with TSS. It is therefore the colloids that carry part of the Hg concentrations found in the Davo River.

The turbidity and metals relationship has been addressed in the study of [25]. To highlight the link between turbidity and metals, [25] showed that when raw water with a turbidity value of 127 NTU was treated at the Béni Nadji station on the Senegal River in Mauritania, the Fe content was reduced from 210 $\mu\text{g/L}$ to 20 $\mu\text{g/L}$ after decantation. The turbidity was also reduced to 2.14 NTU, Pb content went from 2 $\mu\text{g/L}$ to 0 $\mu\text{g/L}$ and Cu content from 184 $\mu\text{g/L}$ to 8 $\mu\text{g/L}$.

The strong negative correlation between Cr and TSS would indicate that part of the transport of Cr in water is done in the aqueous solution [23] [24]. These authors showed that this fraction could reach 33 to 42% of that observed in the particulate phase.

5. Conclusion

The purpose of this study was to assess the physical and chemical quality of the Davo River at its hydrometric station in Dakpadou with a perspective of future drinking water supply projects and to protect the populations that currently consume these waters. The temperature, pH, EC and TSS parameters have average values that respect the standards fixed by the WHO for drinking water. As for turbidity, its average value (10.18 NTU) is higher than 5 NTU which is the threshold value fixed by the WHO. For the major ions (Cl^- , NO_3^- , HCO_3^- and SO_4^{2-} ; Mg^{2+} , Ca^{2+} , Na^+ and K^+) no health risks for consumers were found. In terms of TME, only the concentration recorded in November for Fe can lead to a metallic taste in the water or stains in the laundry. However, this value does not cause health hazards according to the WHO guidelines. Future studies could include work on organic micropollutants because deforestation and the use of phytosanitary products in the exploitation of agricultural plots has increased in recent years. They could also extend to the microbiological study of these waters and concern both the water and sediment matrices of the Davo River.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper

References

- [1] Tohouiri, P., Soro, G., Ahoussi, K.E., Adja, M.G., Aké, G.E. and Biémi, J. (2017) Pollution par les éléments traces métalliques des eaux de surface en période de hautes eaux de la région de Bonoua (Sud-Est de la Côte d'Ivoire). *Larhyss Journal*, **29**, 23-43.
- [2] Eblin, S.G., Sombo, A.P., Aka, N., Kambiré, O. and Soro, N. (2014) Hydrochimie des eaux de surface de la région d'Adiaké (Sud-est côtier de la Côte d'Ivoire). *Journal of Applied Biosciences*, **75**, 6259-6271. <https://doi.org/10.4314/jab.v75i1.10>
<https://www.ajol.info/index.php/jab/article/view/102659>
- [3] Ahoussi, K.E., Koffi, Y.B., Kouassi, A.M., Soro, G., Soro, N. and Biémi, J. (2012) Étude des caractéristiques chimiques et microbiologiques des ressources en eau du bassin versant du N'zi: Cas de la commune de N'zianouan (Sud de la Côte d'Ivoire). *International Journal of Biological and Chemical Sciences*, **6**, 1854-1873.
<https://www.ajol.info/index.php/ijbcs/article/view/84044>
<https://doi.org/10.4314/ijbcs.v6i4.40>
- [4] PLAN GIRE (2022) Etats des lieux des ressources en eau et du cadre de gestion, Plan d'action national de gestion intégrée des ressources en eau (PLAN GIRE, Tome 1). Min. des eaux et forêts, Côte d'Ivoire, 127 p.
- [5] Baka, D., Kouadio, K.E., Yao, K.T. and Takpa, T.P. (2021) Potentiel de productivité des aquifères de la région de Man (Côte d'Ivoire) par la méthode de krigeage. *Ewash & TI Journal*, **5**, 597-604.
<https://revues.imist.ma/index.php/ewash-ti/article/view/26377>
- [6] Yao, K.T. (2009) Hydrodynamisme dans les aquifères de socle cristallin et cristallophyllien du sud-ouest de la Côte d'Ivoire: Cas du département de Soubré, apport de la télédétection, de la géomorphologie et de l'hydrogéochimie. Mémoire de thèse de l'Université de Cocody (CI) et du CNAM (France), 284 p.
<https://tel.archives-ouvertes.fr/tel-00561648>
- [7] PREMU (2017) Renforcement de l'alimentation en eau potable dans les centres urbains d'Agboville, constat d'impact environnemental et social, Rapport final-Projet de renforcement de l'alimentation en eau potable en milieu urbain (PREMU). Min. des Infrastructures Economiques (MIE), Côte d'Ivoire, 170 p.
- [8] Atchérémi, K.D. (2019) Effet du changement climatique sur les ressources en eau du bassin versant de la rivière Davo (sud-ouest de la Côte d'Ivoire) et analyse des mesures endogènes d'adaptation: apport de la modélisation hydrologique avec le logiciel hydrotel. Thèse de Doctorat Université Félix Houphouët Boigny de Cocody, Abidjan, 231 p.
- [9] Ardoin-Bardin, S. (2000) Prise en compte des spécificités de l'évapotranspiration en zone semi-aride dans la modélisation globale de la relation pluie-débit. Mémoire de DEA. Université de Montpellier II, Montpellier, 114 p.
- [10] Ashley, R., Bertrand-Krajewski, J.L. and Hvitved-Jacobson, T. (2005) Sewer Solids-20 Years of Investigation. *Water Science and Technology*, **52**, 73-84.
<https://doi.org/10.2166/wst.2005.0063>
- [11] Marechal, A., Aumond, M. and Ruban, G. (2001) Mise en œuvre de la turbidimétrie pour évaluer la pollution des eaux résiduaires. *La Houille Blanche*, **5**, 81-86.

<https://doi.org/10.1051/lhb/2001061>

- [12] Rodier, J. (2009) L'analyse de l'eau. 9^{ème} Edition, Dunod, Paris, 1579 p.
- [13] WHO (2017) Directives de qualité pour l'eau de boisson: 4^{ème} éd. Intégrant le premier additif [Guidelines for Drinking-Water Quality: 4th ed. Incorporating First Addendum]. Organisation mondiale de la Santé, Genève, 564 p.
- [14] Chapman, D. and Kimstach, V. (1996) Selection of Water Quality Variables. Water Quality Assessments: A Guide to the Use of Biota. Sediments. And Water in Environment Monitoring. Chapman Edition, 2nd Edition, E & FN Spon, London, 609 p.
- [15] Aka, N. (2014) Impact des activités anthropiques sur les ressources en eau du département d'Abengourou (est de la Côte d'Ivoire): Apport de l'hydroclimatologie. De la télédétection et de l'hydrochimie. Thèse de Doctorat de l'Université Félix Houphouët Boigny de Cocody, Abidjan, 270 p.
- [16] Aka, N., Kouamé, A., Bamba, S. and Abé, J. (2019) Caractérisation saisonnière des paramètres physico-chimiques des eaux du Bandama. De l'Agneby et de la Mé (Côte d'Ivoire). F. Tech et Doc. Vul. Vol. 2. 24-31.
- [17] Aka, N. and Gboko, Y.D.A. (2020) Suivi de la qualité physico-chimique des eaux du fleuve Sassandra à la station hydrologique de Goulou (Sud-ouest de la Côte d'Ivoire). F. Tech et Doc. Vul. Vol. 2. 28-35.
- [18] Système D'Évaluation de la Qualité des cours d'EAU (SEQ-EAU) (2003) Grilles d'évaluation SEQ-EAU. Version 2. Min De l'Envet du Dev., Durable, 40 p.
- [19] BRGM (1994) Bilan de l'érosion chimique et mécanique dans un bassin forestier en milieu tropical humide, prospection aurifère de Yaou. Guyane Française. 155 p.
- [20] Molinier, M. (1976) Qualité des eaux de surface en zone forestière équatoriale de Côte d'Ivoire. *Cahiers ORSTOM, Série Hydrologique*, **13**, 7-36.
- [21] Agbri, L., Bamba, B.S., Doumouya, I. and Savane, I. (2010) Bilan des flux de matières particulaires et dissoutes du Sassandra à Gaoulou pont (Côte d'Ivoire). *Sciences & Nature*, **7**, 107-118. <https://doi.org/10.4314/scinat.v7i2.59944>
<https://www.ajol.info/index.php/scinat/article/view/59944>
- [22] Gone, D.L., Adja, J.T., Kamagate, B., Kouame, F., Koffi, K. and Savane, I. (2008) Elimination du fer et du manganèse par aération-filtration des eaux de forage en zone rurale dans les pays en voie de développement: cas de la région de Tiassalé (Sud de la Côte d'Ivoire). *European Journal of Scientific Research*, **19**, 558-567.
- [23] Berryman, D., Guay, I. and Beaudoin, J. (2012) Concentrations de métaux et toxicité de l'eau de la rivière Charest en aval de l'ancien site de Notre-Dame-de-Montauban. Ministère du Développement Durable, de l'Environnement et des Parcs, Direction du suivi de l'état de l'environnement, Québec, 40 p.
- [24] Garneau, C. (2014) Modélisation du transfert des ETMs dans les eaux de surface. Thèse de l'Univ., de Toulouse, 221 p.
- [25] N'diaye, D.A., Tiam, O., Sid'hamed, O.M. and Namr, I.K. (2013) Turbidité et matières en suspension dans l'eau: Application à l'évaluation des métaux contenus dans l'eau de la rive droite du fleuve Sénégal. *Larhyss Journal*, **14**, 93-105.
https://lab.univ-biskra.dz/Larhyss/images/pdf/Journal12/5.N_Diaye_et_al.12.pdf