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Research Article

Physico-Chemical Factors of Lubilanji River (Oriental Kasaï Province, Democratic Republic of the Congo)

Abstract

Background and aim: Fishing and fish farming sectors currently face major challenges related to the lack of knowledge of data on the physico-chemical quality of water bodies from Lubilanji River. This investigation intended to determine the physico-chemical parameters of Lubilanji River.

Methods: Fourteen physico-chemical parameters were studied in Lubilanji River including temperature, turbidity, transparency, conductivity, pH, alkalimetric title, total hardness, calcium, nitrate, phosphate, oxygen dissolved, depth, width and velocity.

Results: The analysis showed that average value of transparency in all stations is of 54.09 cm with coefficient of variation of 31.84%. While the average of water velocity is 91.30 m/s with coefficient of variation of 49.80% in all stations. The parameters like water velocity, turbidity, temperature, calcium and pH indicated their low influence on stations. According to the results found, the Libilanji River should be rich in ichthyological biodiversity.

Introduction

Fishing and fish farming in the Democratic Republic of Congo are classified among the priority sectors of agriculture in the context of the Millennium objectives to reduce hunger and poverty [3, 14]. However, these sectors currently face major challenges related to the lack of knowledge of the quality of water which is the most important resource and uncontrolled expansion of the fishing techniques [9]. A good knowledge of these aquatic environments, ensures their use, including through studies on the physico-chemical quality of water, aquatic biodiversity, spatial distribution of species in relation to their habitats.

Indeed, data on the physico-chemical quality of water and aquatic biodiversity are oldest for this River of Oriental Kasaï.

This work intended to determine the physico-chemical parameters of Lubilanji River for its rational use in order to assure a sustainable management.

Material and Methods

Study area

Lubilanji River is located in the province of Oriental Kasaï in Democratic Republic of Congo and extends between 6°3' and 6°11' S latitude and between 23°33' and 23°50' E longitude. The average annual rainfall is about 1400 mm. The average annual temperature is 23°C.This investigation was carried out in ten stations (Figure 1) that AVB1 (station1), AVB2 (station2), CHU3 (station3) AMB4 (station4), LUI5 (station5), LUI6 (station6), LUI7 (station7), MBM8 (station8), MBM9 (station9), MBM10 (station 10).

Sampling procedure

Physico-chemical parameters were carried out twice a month between 08H and 10H at strategic positions from July 2009 to September 2011. Samples consisted of 0.5 dl (decilitre) of water collected.

Water temperature, *dissolved oxygen*, *electrical conductivity* and *pH* were measured in situ at each of the stations using digital probe apparatuses.

Water transparency: was measured using circular Secchi disk.

Turbidity: was measured by field devices.

Water velocity: was measured in situ by the use of water current meter in cm/s.

Water depth (m): was measured in situ using a wooden meter or a calibrated stick.

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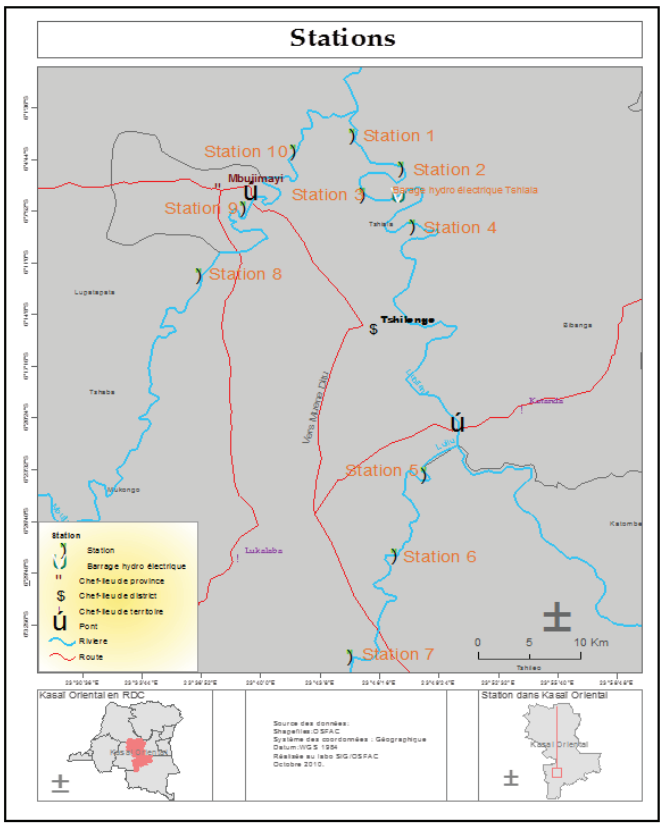

Figure 1: Map showing the sampling stations of investigation.

Width (m): was measured in situ using a decametre

Alkalinity: alkalimetric title was determined using volumetric method in the laboratory [12]. This method involves a direct titration of water sample (5 ml) with hydrochloric acid.

Calcium and total hardness: were determined by titration method in the laboratory.

Nitrate: was measured in the laboratory using spectrophotometric calorimeter (HACH DR/2000)

Phosphate: was determined using molybdo-vanadic reagent in the laboratory.

Data analysis

Statistical analyses were performed using Excel as well as we computed a Principal Component Analysis (PCA) to assess the relationship between the sampling stations and physico-chemical parameters.

Results and Discussion

The values of fourteen physicochemical parameters were recorded including water temperature, dissolved oxygen, electrical conductivity, pH, turbidity, depth, width, water velocity, transparency, total hardness, alkalimetric title, calcium, nitrate and phosphate (Table 1).

This table showed that average value of transparency in all stations is of 54.09 cm with coefficient of variation of 31.84%. While the average of water velocity is 91.30 m/s with coefficient of variation of 49.80% in all stations.

The average temperature of Lubilanji River is of 21.04°C with minima and maxima ranging from 17.33 to 25.83°C. Note that the temperature recorded in Lubilanji River is suitable to ensure biological activities as reproduction and growth.

The temperature recorded in Luilu River (DRC) by Mulangu [8] varied between 14°C and 17°C on surface water and from 14.5 to 16.5°C in deep water. De Kinkelin [2] reported that water temperarure of tropical regions varies between 15°C and 30°C.

It was observed that the water bodies of Lubilanji River have a reddish coloration in upstream and slightly brown in fall until downstream where they are greenish-brown. The findings of Mulangu [8] showed that the water bodies of Luilu River had a slightly green and greenish-brown color and a content of turbidity ranging from 0.35 to 0.6 NTU on water surface and from 0.45 to 0.4 NTU in depth.

Muvundja [15] recorded the average values of temperature, conductivity and pH in Kawa River of 21.5°C, 638 µs/cm and 7.4 respectively. He noted that the sampling sites affected by human disturbance showed higher temperature fluctuations.

The findings of Lumami et al. [16], recorded in Ruzizi River showed that the average values of temperature and pH are 24.9°C and 9.1 respectively. They indicated Ruzizi is an important River because it connects Lake Kivu to Lake Tanganyika, its physico-chemical parameters are most complex because they vary according to properties from some streams.

The higher values of pH reported in Kawa and Ruzizi Rivers and higher value of conductivity in Kawa River than Lubilanji River could be explained by the fact that Kawa and Ruzizi Rivers are located in volcanic region.

Talling [13] showed that water transparency of white Nile River was virtually reduced to zero by the mud in suspension while it varied between 0.1 and 0.4m in June 1974 because of debris due to the displacement of minimal extinction coefficient in visible light from 5 to 10 units/m. Lowe-McConnell [6] established a relationship between water coloration and pH, he concluded that black water Rivers are very acidic with pH of 3.8 to 4.9, poor in inorganic ions, which reflected low development of plankton and low oxygen dissolved because of decomposition of plant debris.

The pH values found in Lubilanji River range from 4.56 to 6.86 with an average of 5.68 are not similar to these reported in Luilu River (7.1 to 7.2 on water of surface and 7.2 to 7.5 in depth) by Mulangu [8]. The pH values recorded are well within the required limits (5 to 9) for survival, reproduction of fish and plankton productivity [11].

The alkalimetric title values recorded in Lubilanji River compared to these found by Mulangu [8] in the River Luilu (14.4 to 16°F on surface water and 14.6 to 15.9°F in depth) showed that the alkalimetric title tends to increase. This increase would be due to the very remarkable limestone in the region.

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Calcium and total hardness values recorded show that Lubilanji River is a natural rich ecosystem in fish because the calcium and total hardness standard values are of 12.2°F to 35°F for a normal production of fish [2].

The results of Mulangu [8] indicated the presence of nitrite in minimal quantity in the Luilu River (0.0045 to 0.011 mg/l on surface water and 0.001 to 0.015 mg/l in depth). Gosse [5] reported the nitrate value of 0.1 to 0.21 mg/l in Bohamba River, 0.3 to 14.15mg/l in Lake Upemba, 0.1 to 0.5mg/l in Lake Moero, 0 to 0.2mg/l in Lake Tanganyika and 0 to 0.1mg/l in Lake Victoria. However Mulangu (2007) observed high phosphate values in Luilu River of 2 to 2. 65 mg/l on surface and 2.5 to 2. 8 mg/l in depth. Rodier [11] reported that algae spirogyre sp is able to grow in the water bodies with high quantity of phosphorus.

Mulangu [8] also showed that dissolved oxygen recorded on surface was of 5.625 mg/l and 2.565 mg/l in depth of Luilu River. While Nyongombe [10] recorded a dissolved oxygen value of 4.6 in Masendula River in Kisangani, DR Congo. Gosse [5] found a value of 4.6 mg/l in Bohamba River [1,4,9,10], reported respectively the lowest values of dissolved oxygen of 1.4mg/l, 2.3mg/l, 2.7mg/l and 2.8mg/l.

The findings of Mulangu [8] from Luilu River indicated that water velocity values ranged between 10 and 25cm/s in downstream of dam and between 25 and 50cm/s in upstream of dam.

Relationship stations-physicochemical factors

The percentage of variances of the first two axes (93.6%) explained AVB1, CHU3, LUI5 and LUI7 stations are characterized by depth and transparency. MBM8 and MBM10 stations are characterized by phosphate and conductivity. While the important width is reported in the AMB4, LUI6 and AVB2 stations. AVB1, CHUT3, LUI5 AND LUI7 stations are characterized by dissolved oxygen, nitrate, alkalimetric title and total hardness. The parameters like water velocity, turbidity, temperature, calcium and pH found outside the correlation circle showed their low influence on stations (Figure 2).

Table 1: Values of fourteen physicochemical parameters of Lubilanji river

No	Parameters	Unity	Min	Max	Mean	Stdev	CV(%)
1	Temperature	°C	17.33	25.83	21.04	2.04	9.69
2	Turbidity	NTU	0.21	0.58	0.37	0.08	21.62
3	Transparency	Cm	26.00	88.96	54.09	17.2	31.84
4	pH	-	4.56	6.86	5.68	0.52	9.15
5	Alkalimetric title	°F	13.72	18.35	15.92	1.81	11.39
6	Total hardness	°F	12.56	14.43	13.55	0.41	3.03
7	Calcium	°F	7.73	10.46	9.27	0.59	6.36
8	Nitrate	mg/l	0.76	1.46	1.13	0.13	11.50
9	Phosphate	mg/l	0.75	1.76	1.03	0.26	25.24
10	Dissolved Oxygen Deth Width Conductivity Velocity	mg/l m m µS/cm m/s	5.20 1.10 11 66.5 23	9.20 2.90 32 158.9 160	7.71 2.10 21.50 88.4 91.30	0.86 1.59 2.01 25.64 19.50	11.86 6.73 8.54 29.01 49.80

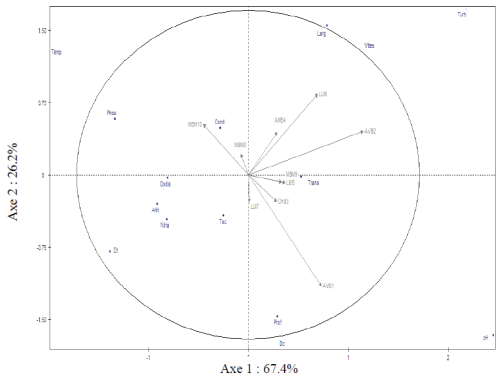

Figure 2: Principal Component Analysis expressing the relationship stations-physicochemical parameters. **Temp**= temperature, **Cond=** conductivity, **Vites**= water velocity, **Turb**= turbidity, **Prof**= depth, **Larg**= width, **Oxdis**= dissolved oxygen, **Phos**= phosphate, **Nitra**= nitrate, **Tac**= alkalimetric title, **Dc**= calcium, **Dt**= total hardness, **Trans**= transparency.

Matthews [7] showed that the distribution of the fish is largely influenced by quality of physico-chemical factors such as temperature, transparency, turbidity, pH, alkalimetric title, conductivity, total hardness, calcium, nitrate, phosphate, oxygen dissolved, depth, width, water velocity.

Conclusion

The temperature, turbidity, transparency, depth, width and velocity were recorded as physical parameters, while alkalimetric title, total hardness, calcium, pH, nitrate, conductivity, phosphate and oxygen dissolved as chemical parameters.

The average water temperature recorded in Lubilanji River is of 20.71°C. Note that the temperature reported in Lubilanji River is suitable to ensure biological activities as reproduction and growth. The water bodies of Lubilanji River are slightly acidic with average pH of 5.68. The average value of dissolved oxygen recorded reaches 7.71 mg/l

From these results, we note that Lubilanji River is a natural ecosystem that should be rich in ichthyological biodiversity. Thus, in order to promote fisheries and fish farming in Democratic Republic of the Congo, we have to control the water quality of Rivers because it determines the quantity of natural foods of fish such as zooplankton and phytoplankton that are available in the Rivers.

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