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Physicochemical characterization of peat in the Mpama bog in the Congo Basin in North-western DR Congo

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ABSTRACT

This study is a monitoring of peatlands that aims to determine their natural state in order to obtain scientific information on their physical and chemical properties. It contributes to the characterization of natural capital by evaluating the physical and chemical parameters of peat in the peatlands of the Congo Basin, specifically that of Mpama, with a view to the sustainable management of this ecosystem. The following parameters were determined: temperature (T), hydrogen potential (pH), electrical conductivity (EC), total dissolved solids (TDS), oxidation-reduction potential (ORP), dissolved oxygen (O_2), total organic carbon (TOC), moisture (H), density (D), cellulose (CEL), lignin (LIGN), and ash content (TC). The results obtained show variation in the physicochemical parameters analyzed from one sampling point to another. Overall, Mpama peat is acidic, rich in organic matter, very wet, and low in minerals; it has high carbon storage potential, and its low density and high moisture content confirm that it is still actively decomposing.

Key Words: Peat, Physicochemical, Peat Bog, Natural State.

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1. INTRODUCTION

Peat lands are currently one of the most valuable ecosystems in addressing the problems caused by climate change because of the amount of carbon they sequester. It is good to have peatlands, they are a valuable resource, and the Democratic Republic of Congo is promoting itself as a country that can help tackle climate change, thanks in particular to its numerous peatlands and forests. Wetlands known as peatlands cover only 3% of the total land area. They are very rich in organic matter and can store nearly 20% of the planet's organic soil carbon. They are important sources of organic carbon transfer to surface waters. They represent only a small proportion of the landscape cover and are subject to the influence of local anthropogenic activities. Biogeochemical studies in peatlands have so far been limited due to climatic conditions and accessibility. Fortunately, recent advances in optical technology now make it possible to measure organic carbon concentrations in situ and at high frequency in the streams draining these ecosystems [1].

The tropical forests of the Congo Basin cover more than 3.6 million square kilometers and span six countries: the Democratic Republic of Congo, the Republic of Congo, Cameroon, Gabon, the Central African Republic, and Equatorial Guinea [2]. They play an important role in climate regulation. In addition to its size, its importance also stems from the biological resources it contains, both plant and animal [3]. The central basin of the Congo Basin is a vast swamp forest that is difficult to access. It is better preserved than other types of forest [4]. It is the second largest wetland in the tropics. According to the NGO CongoPeat, the peatlands of the Congo Basin cover an area of 145,000 km² and store approximately 30.6 pentagrams of carbon [5] (Dargie G. et al., 2017).

Peatlands account for about half of the world's wetlands [6]. Peat is dead, partially decomposed plant matter that has been preserved over long periods of time in waterlogged conditions. When intact, peatlands provide many ecosystem services. They trap and store carbon, help regulate water cycles, purify water, and harbor rich biodiversity.

The exploitation of peatlands can cause the loss of their valuable characteristics, such as their unique biodiversity, their carbon storage capacity, and, if flooded, their "terrestrial" nature. To avoid destructive use of these fragile ecosystems and ensure their conservation and wise use, it is necessary to identify, locate, delimit, and study them.
To date, to our knowledge, there are very few studies on the physicochemical characterization of peat in the peatlands of the Congo Basin.
In order to determine the exact nature of peat in the Congo Basin peatlands, it is necessary to analyze its physical and chemical parameters. Can this knowledge contribute to the sustainable management of this unique ecosystem?
We know that human activities are the main sources of pollution in wetland ecosystems. Our study uses a methodology for studying the physical and chemical parameters of peat. The aim is to prevent potential pollution of these wetlands because, if we do not protect them, we risk an increase in the current atmospheric temperature due to the amount of carbon stored by these wetlands.
Our study therefore contributes to the characterization of natural capital by evaluating the physicochemical parameters of peat in the peatlands of the Congo Basin with a view to the sustainable management of these ecosystems.

2. MATERIALS AND METHODS

2.1. Study environment

The village of Mpama is located in the territory of Ingende, in Equateur Province. It is one of the decentralized territorial entities located in the Bokatola sector, Ingende Territory, in the same province. It is situated along the Congo River and its main activities are fishing and subsistence agriculture using slash-and-burn techniques.

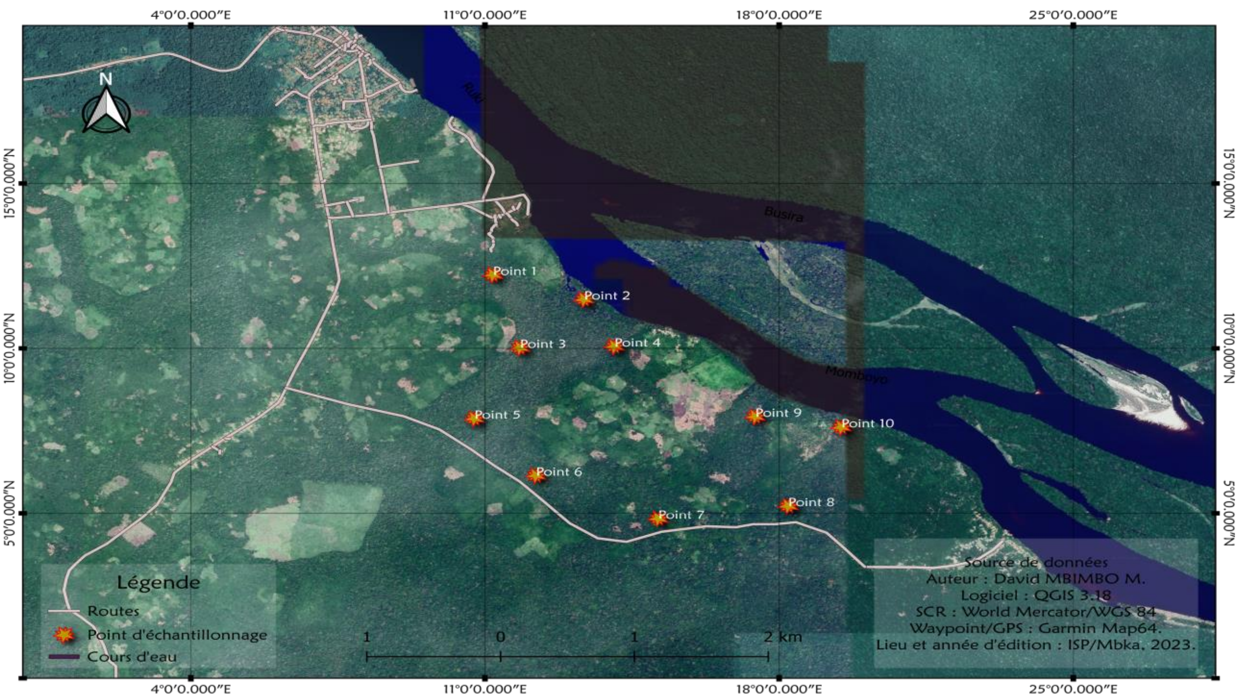

Figure 1: Location of the Mpama area

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2.2. Equipment

The following equipment was used during our study to determine the physical and chemical parameters: HANNA HI 991300 probe; HANNA HI 9146 probe; Spectrophotometer; Centrifuge; Balance; Decanting flask; Test tubes; Hot plate; Watch glass; Beaker; GPS

2.3. Data collection plan and sampling

The study areas cover long distances and large areas. We took 10 samples in the accessible parts. These samples were taken in March 2023.

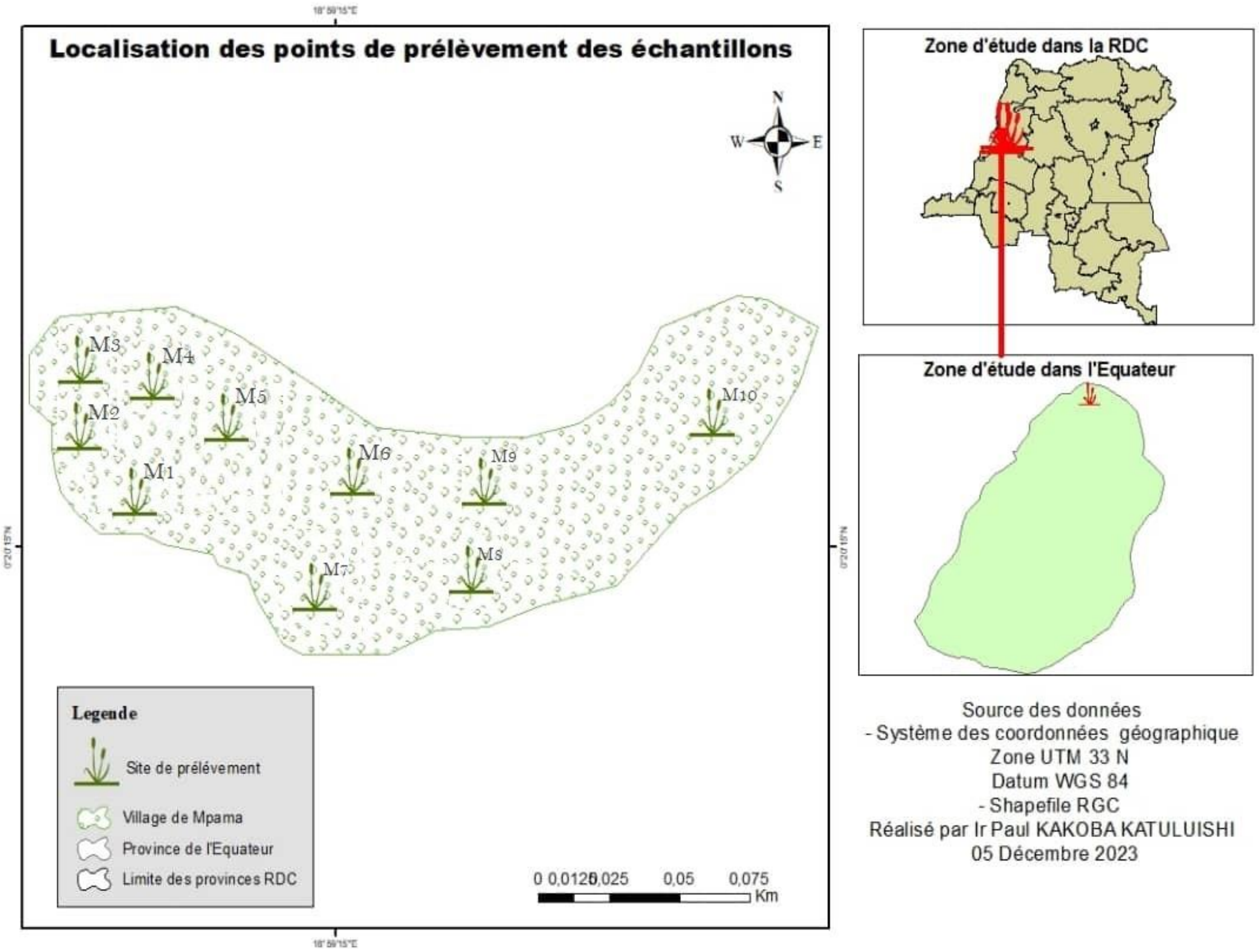

Figure 2: Location of sample collection points at the Mpama

2.4. Physicochemical analysis

The following physicochemical parameters were measured in situ: temperature, hydrogen potential, electrical conductivity, redox potential, dissolved solids content, and dissolved oxygen using two HANNA multi-parameter probes: Hi 9146 and Hi 991300.

The total organic carbon, moisture content, density, lignin, cellulose, and ash content of the peat samples were determined in the laboratory.

2.5. Data processing

Statistical analysis of the data was performed using SPSS software and Microsoft Office Word 2016.

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3. RESULT AND DISCUSSION

3.1. Physicochemical parameters

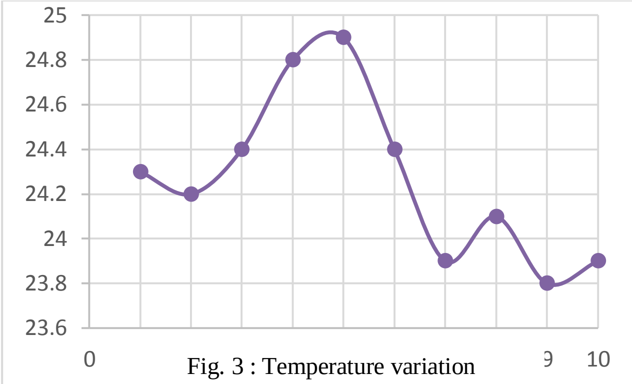

Fig. 3 : Temperature variation

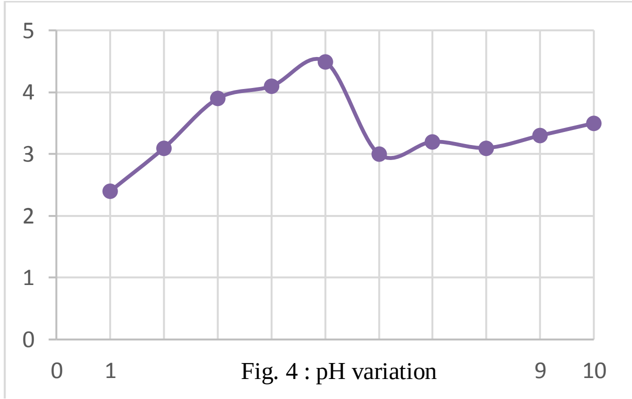

Fig. 4 : pH variation

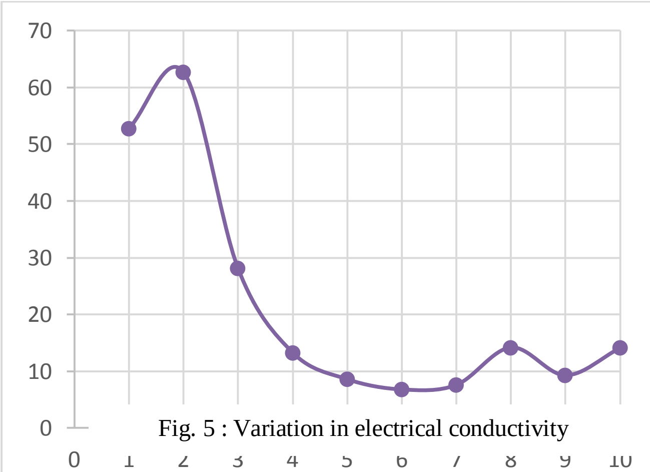

Fig. 5 : Variation in electrical conductivity

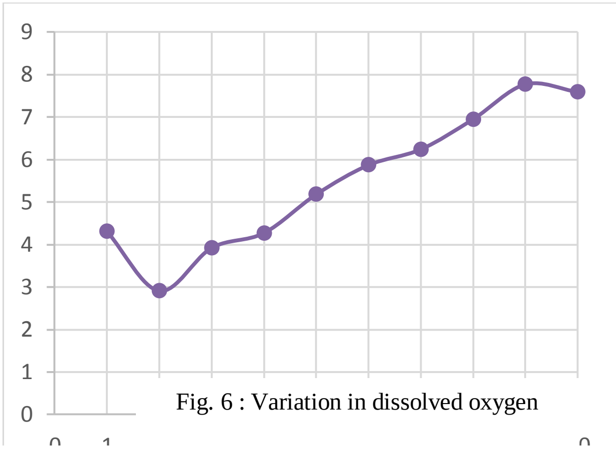

Fig. 6 : Variation in dissolved oxygen

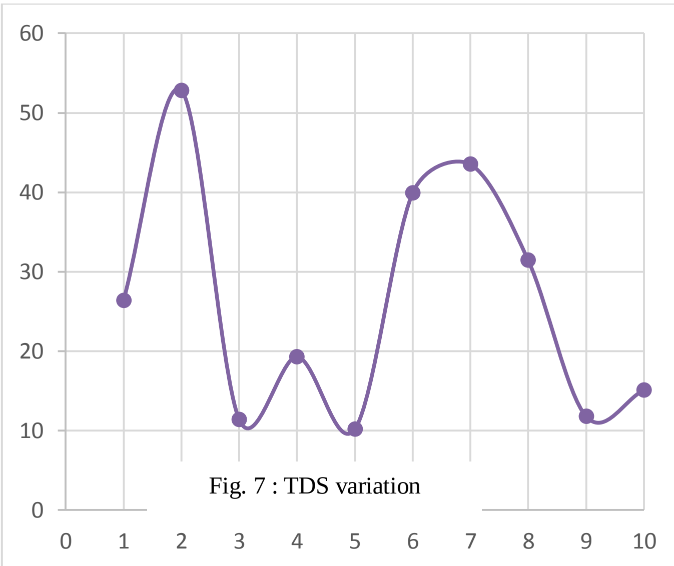

Fig. 7 : TDS variation

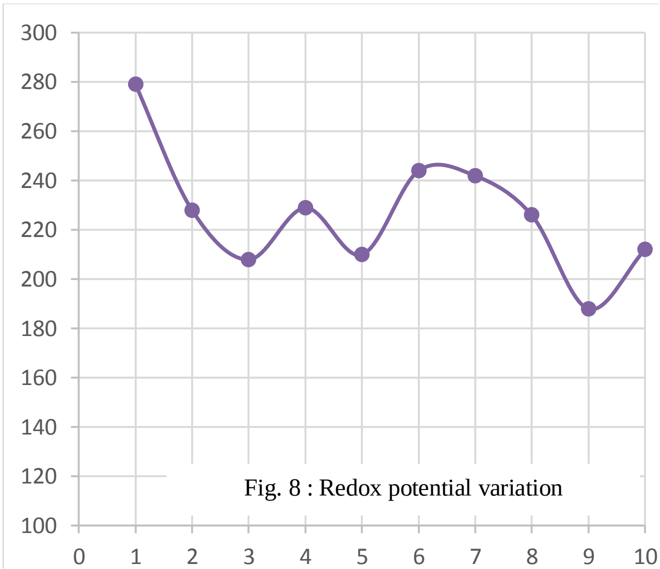

Fig. 8 : Redox potential variation

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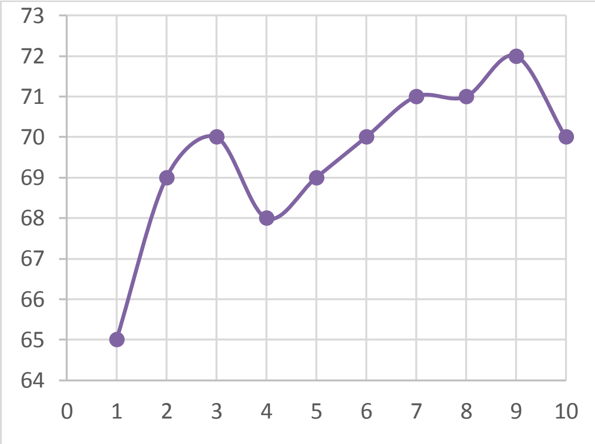

Fig. 9 : Variation in total organic carbon

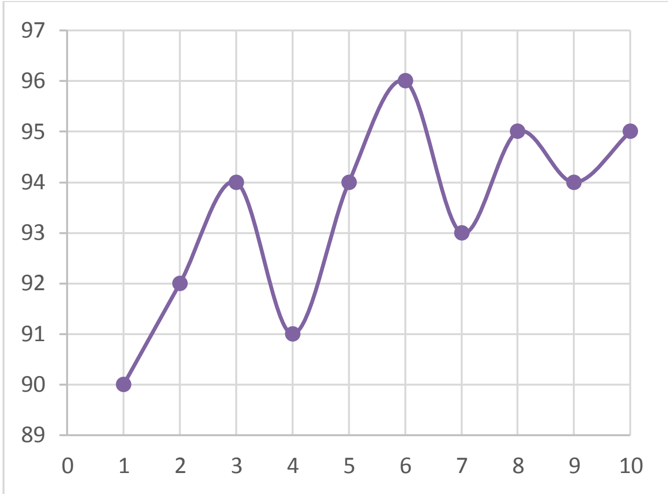

Fig. 10 : Humidity variation

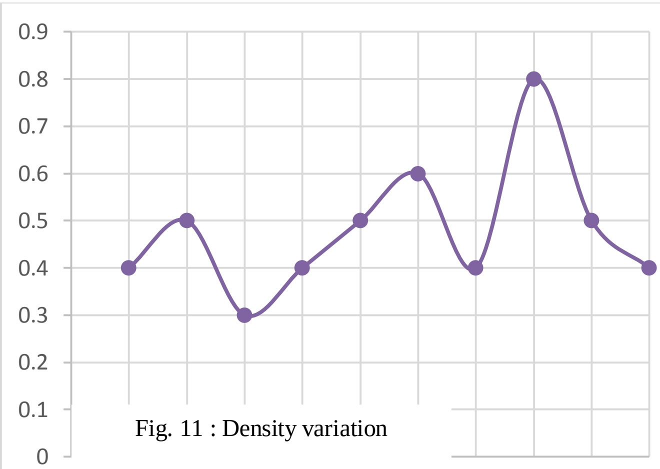

Fig. 11 : Density variation

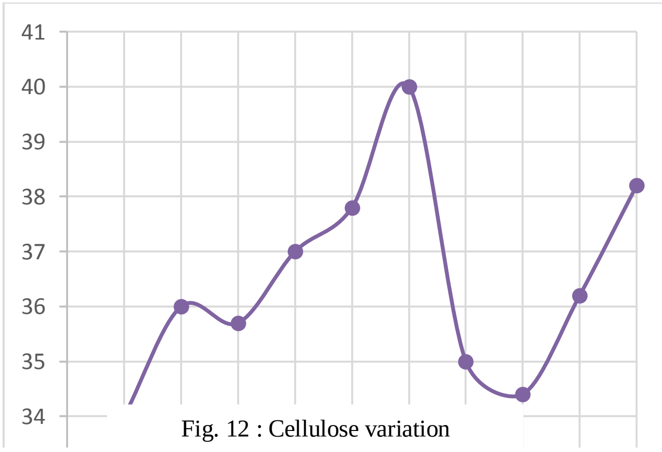

Fig. 12 : Cellulose variation

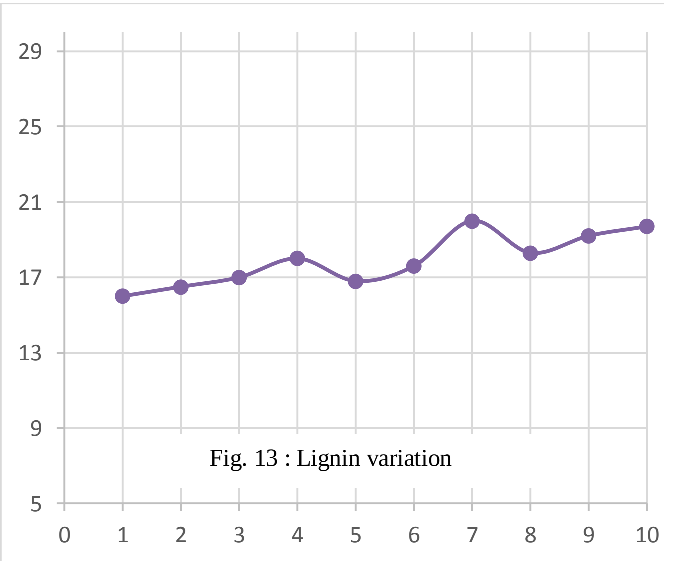

Fig. 13 : Lignin variation

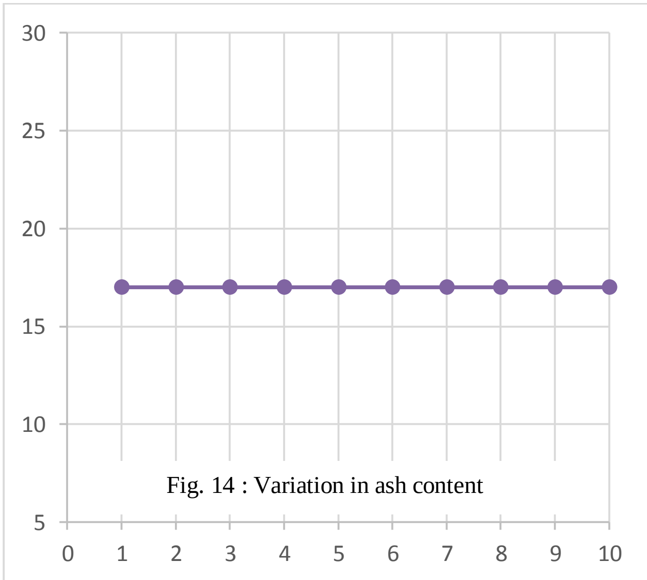

Fig. 14 : Variation in ash content

The temperature values recorded during this study vary between 23.8 and 24.9°C, with an average of 24.27°C and a standard deviation of ± 0.37; the minimum value is recorded at point 9, and the maximum is observed at point 5. As for pH, all values were between 2.4 and 4.5, with an average of 3.41 and a standard deviation of ±0.61; the lowest value was recorded at point 1, and the highest at point 5. Furthermore, the electrical conductivity measured varies between 6.8 and 62.2 µs/cm, with an average of 21.7 µs/cm and a standard deviation of ± 19.94; points 6 and 2 mark

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the minimum and maximum values, respectively. Dissolved oxygen varies from 2.9 to 7.7 mg/L with an average of 5.5 mg/L and a standard deviation of ± 1.65; its minimum value is recorded at point 2 and its maximum at point 9. TDS varies between 10.2 and 52.8 mg/L, with recorded values averaging 26.19 mg/L and a standard deviation of ± 15.17; points 5 and 2 have minimum and maximum values. The redox potential varies between 188 and 279 mV, with an average of 226.6 mV and a standard deviation of ± 24.98; the minimum value is recorded at point 9 and the maximum at point 1. Total organic carbon varies between 65 and 72%, with an average of 69.5% and a standard deviation of ± 1.95; its lowest value is recorded at point 1, and its highest value at point 9. Peat moisture values during this study vary between 90 and 96%, with an average of 93.4% and a standard deviation of ± 1.89; the minimum value is recorded at point 1, and the maximum at point 6. Density values ranged from 0.3 to 0.8, with an average of 0.4 and a standard deviation of ± 0.1; the lowest value was recorded at point 3, and the highest at point 8. Cellulose values range from 34 to 40% with an average of 36.43% and a standard deviation of ± 1.85; the minimum value is recorded at point 1, the maximum at point 6. As for lignin, all values are between 16 and 20% with an average of 17.91 and a standard deviation of ± 1.38; the lower value is recorded at point 1, the higher value at point 7. The ash content does not vary; it is the same in all samples in our study.

These results show:

- A thermally stable environment
- Acidic peatlands
- Few mineral ions
- Low mineralization
- Extremely wet peat
- Plant matter still recognizable
- Organic matter is partially decomposed

Overall, the results are similar to those found by: Andersen, 2006 in Quebec peat where the pH varied between 3.2 and 4.4; Andersen in 2011 where electrical conductivity varied between 27 and 64 µs/cm; Miryane Ferlatte in 2016, where TDS varied between 9 and 15 ppm.

Total organic carbon averages 69.5%. [7] This is higher than the results found by M'SADAK and BEMBLIH in Sousse peat in Tunisia in 2018, where the percentage variation in their peat samples was 43.72 to 50.69%. Organic carbon plays an important role in climate regulation and is an essential element of soil fertility. It accounts for 25% of the potential of nature-based solutions identified to combat climate change. [8]

4. CONCLUSION

This study focuses on the physicochemical characterization of Mpama peat, one of the peatlands in the Congo Basin. This characterization allows us to determine its natural state and, consequently, to obtain scientific information about this site. To this end, a matrix was studied, namely peat.

The results of this study show variations in the physicochemical parameters analyzed from one sampling point to another. Overall, Mpama peat is acidic, rich in organic matter, very wet, and low in minerals; it has high carbon storage potential, and its low density and high moisture content confirm that it is still actively decomposing.

Ultimately, we believe that the creation of a database would enable the management of peatlands in the central basin, as well as furthering knowledge about this type of ecosystem.

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