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Physico-Chemical Characterization of the Nangongo Peat Bog in South Kivu Province, DRC

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Abstract

The physico-chemical characterization of the Nangongo peat bog in South Kivu province, Democratic Republic of Congo (DRC), was conducted in this study. The results show that the characteristics of this peat bog are like those of other peat bogs presented in the literature. The Nangongo peat bog belongs to the ombrotrophic peat bog category. The physical and chemical characteristics of the samples analyzed showed a generally low ash content compared with the volatile matter content, and a deficiency of certain minerals such as silica, calcium, and magnesium oxides. The average organic carbon content of 51.2% classifies it as a mature peat bog. As for calorific value, this is of the order of 5584 kcal/kg, higher than the limit required by certain authors for the use of peat as fuel.

Subject Areas

Earth & Environmental Sciences

Keywords

Peat Bog, Peat, Ash Content, Volatile Matter, Calorific Value

1. Introduction

Global warming, on a planetary scale, represents a major challenge and is attracting particular attention from society and the scientific community. As a result, the trend is to observe studies that are part of the fight against global warming by researching and discovering sources of production and sinks for storing greenhouse gases. Various environments require special protection because of their high sensitivity to the effective contribution they can make to global warming once their natural ecosystem balance has been disturbed [1]. The role played by wetlands, and in particular peat bogs, in the ecological balance is attracting much greater attention, and is almost universally recognized by many authors, prompting calls for their protection [1]-[6]. A wetland is defined as a natural or man-made environment that is permanently or temporarily overflowing with water, occupying either a bed or saturated soil, and whose state can be either moving or stagnant [7].

The central basin (Congo Basin) alone covers 145,000 km^2 of peat and stores around 30.6 pentagrams of carbon [8]. The Democratic Republic of Congo (DRC) occupies 62.4% of this area and stores around 19.1 pentagrams of carbon [9]. Applying the method of Bwangoy *et al.* [10]), peatlands occupy around 40% of the total wetland area of the central basin [11]. With the discovery made in 2017, the DRC is ranked as the second most important country in the tropics in terms of surface area and the fifth country in terms of carbon stocks [8]. Despite this discovery, the complete mapping and geolocation of peatlands in the DRC is not complete. Notwithstanding the goods and services that peat can provide, and the enormous need for energy felt by local communities, the valorization of peat from peatlands in the DRC has not been developed.

In the province of South Kivu, in its city of Bukavu, the main source of household cooking energy whose use is estimated at 97% is wood and charcoal [12]. According to the report published by the Programme de Développement de Gestion Informatique Energétique (PDGIE) in 2018, energy consumption in terms of wood burning represents around 94% of energy consumption over the DRC's territorial expanse [13]. This strong dependence on a single source leads to intense deforestation as a result of charcoal production.

This strong dependence means that the search for other fuels that can provide a service similar or comparable to that offered by charcoal is encouraged. Peat was one of the materials identified following studies carried out by several researchers [14] [15] [16]. Peat can also be used as household cooking energy by producing peat briquettes. These could meet the high energy demand that is increasing with population growth, and contribute to reducing the rate of deforestation and diversifying energy sources in the region. The main objective of this study is to determine the physico-chemical characteristics of the Nangongo peat bog, with a view to its use in the production of briquettes for fuel. The main objective is followed by four (4) specific objectives:

- Sampling and preliminary quantification of peat from the Nangongo peat bog;
- Classify the Nangongo peat bog according to the literature and the Von Post scale;
- Determine the physical and chemical characteristics of Nangongo peat bog samples;
- Carry out statistical analyses between different variables of the physico-chemical composition of the peat.

2. Materials and Methods

2.1. Site Location, Climatic and Geological Context

2.1.1. Location of Study Site

The Nangongo peat bog site is in the Walungu territory, about 45 km from the city of Bukavu. The area is bordered to the north by the Kabare territory, to the south by the Mwenga and Shabunda territories, to the east by the Uvira territory, the Ruzizi River, the Republic of Rwanda, and the Republic of Burundi, and to the west by the Kabare territory (**Figure 1**). The study area is marked by a rugged relief, with high mountains and hills interspersed throughout [17].

2.1.2. Climatic, Pedological and Vegetative Context

The Nangongo site is characterized by a humid tropical climate with alternating dry and rainy seasons. The dry season extends over a period of around 3 months (mid-June to the end of August) and the rainy season lasts 9 months (September to mid-June). Annual rainfall averages between 1500 and 1800 mm [17], and average annual temperatures range from 19˚C to 30˚C [18].

In terms of soil conditions, Walungu's territory is generally made up of clayey-sandy soils of the red laterite type, loose black soils, stony soils, and

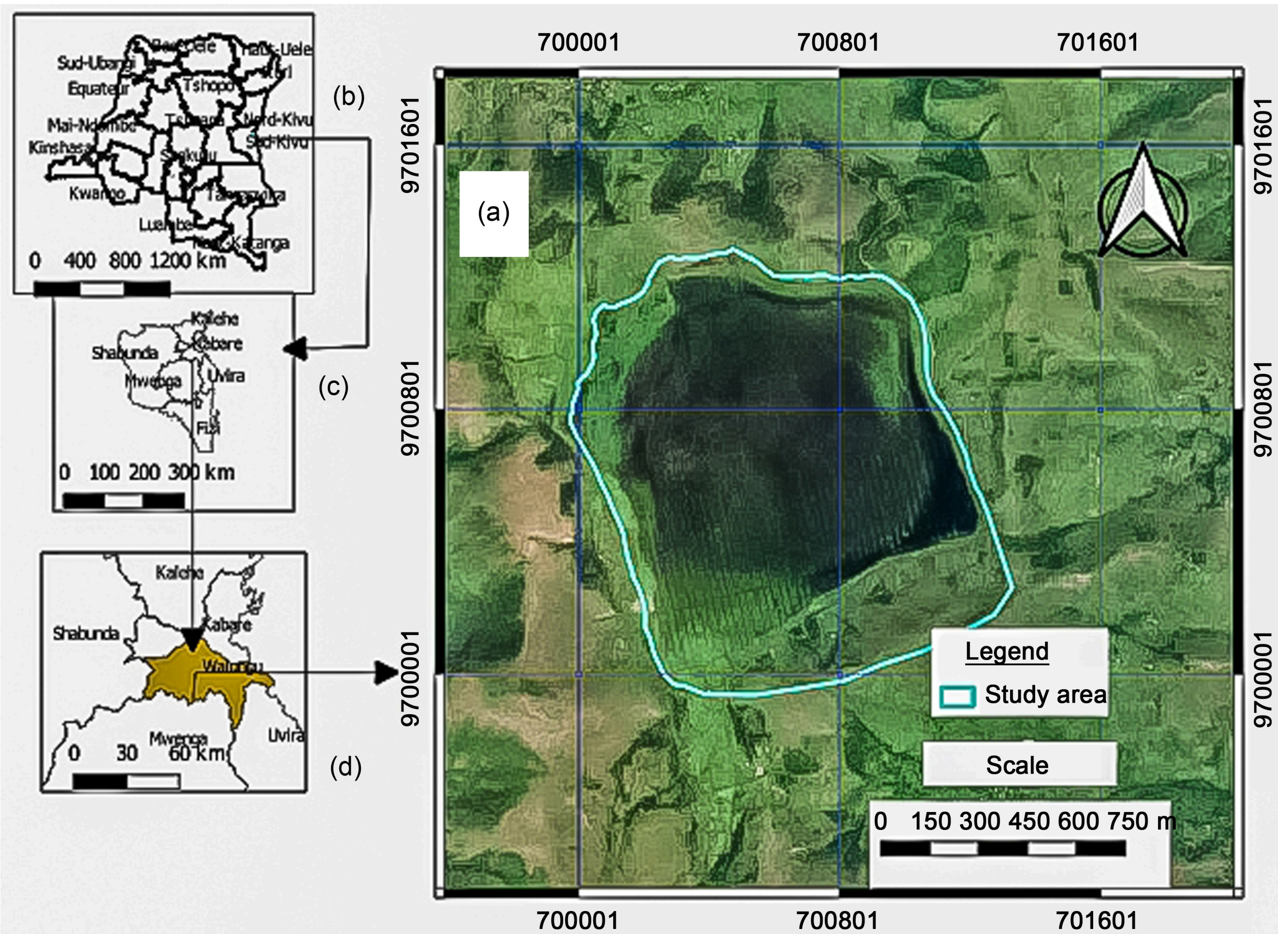


Figure 1. View of study area (a) located in the map of DRC, in South Kivu province (b) and in Walungu territory (c) and (d).

alluvial soils in the lowland marshes [19]. Grassland vegetation is the most dominant in this area. Other types of vegetation, such as meadows and remnants of ancient natural forests, can be observed in some of the ravines [19].

2.1.3. Local Geological Context

The lithostratigraphy of the local geology of the Walungu territory is mainly made up of powerful quartzite levels (Bangwe formations), followed by a mainly schistose and quartzophylladic ensemble (Mukubio formations) and also with quartzites and quartzophyllades, sometimes conglomeratic, very rich in magnetite and oligiste crystals (Mughéra formation) [20] [21].

2.2. Sampling and Material Preparation

2.2.1. Peat Bog Identification and Delimitation

The first stage of this part of the study involved a review of existing data and publications on the study area. This step enabled us to understand the history of the study area and to assess the impact of current or past activities on the bog's physico-chemical characteristics.

The second stage involved a reconnaissance visit to the site on August 11, 2022, to ascertain the existence of the peat bog, its surface delimitation, and its current and past use, through interviews with nearby residents. The existence of the peat bog was confirmed by a physical test consisting of exerting a force on the surface of the ground by the feet and assessing the intensity of soil rebound [22], as well as by the permanent presence of water in certain areas.

The topographic survey of the 24 points of the bog was also carried out using the Android GPS Point application. The topographic data was then used, with the aid of Google Earth software, to create the geographical location map and estimate the perimeter and area of the bog. The second stage of this part of the study ended with the observation and photography of certain features of the site.

2.2.2. Peat Sampling

Based on a review of previous site data and information gathered during the reconnaissance visit, a sampling pattern was established with the location of various sampling points. Sampling was targeted for certain areas of the bog to avoid zones where the soil had been disturbed and reworked by previous activities. For reasons of inaccessibility, systematic random sampling, which is generally recommended [23], was not possible. Instead, the technique adopted in this study was random transect sampling combined with targeted sampling. Two major transects 300 m apart were selected. Along the transects, sampling was carried out every 280 m on average, depending on the accessibility of the selected stations. A total of thirteen (13) samples were predefined: ten (10) samples along the transects and three (3) samples at targeted locations (**Figure 2**).

During the second field visit on October 20, 2022, samples were taken at each station. A hand auger (25 cm long, 7 cm in diameter, with a 125 cm rod connected to a T-wrist) and a sampling tube as recommended in the literature by some authors were used [24].

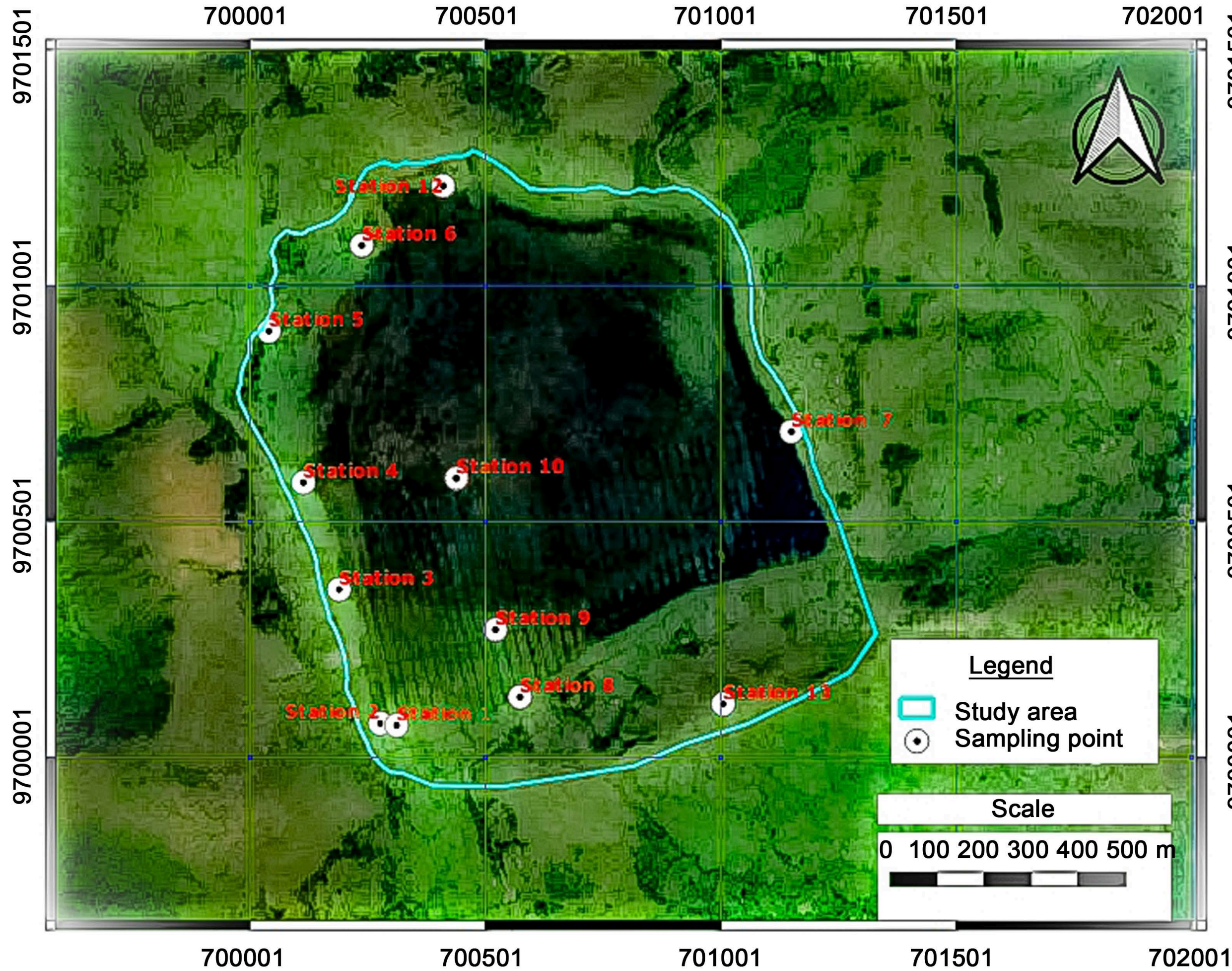


Figure 2. Sampling map.

The surface layers of the plants were stripped before each sampling, taking care to preserve the organic part under the vegetation.

Sampling was carried out first with the sampling tube (in one pass), then with the hand auger (in several passes) until the maximum stem length was reached. Tube sampling consisted of taking a sample by pushing the open tube (50 cm long and 7 cm in diameter) into the soil from the surface. Once fully inserted, the tube was rotated through 180˚ and returned with the soil sample (core) trapped within it. This type of sampling allows us to observe soil stratigraphy directly in the field, and to take samples with little reworking, making it easier to identify the soil layers obtained. Soil samples are taken using an auger, which is manually driven into the ground in a clockwise rotation. Typically, two or three revolutions will push the auger about 10 cm into the ground. Once the entire length of the auger has been driven in, it is removed from the ground and the sample collected by inverting the auger. This equipment enabled us to reach a maximum depth of 150 cm.

Each sample was described in the field at the time of collection, noting primarily its coloration, moisture content, degree of decomposition and the geographical coordinates (latitude, longitude, and altitude) of each sampling point. Descriptive details also included the presence of any non-soil material, a description of the environment in which the sample was taken, and a classification of the peat according to its degree of decomposition on the Von post scale [25]. After description, the samples were packed in black rubber bags, identified, well-packaged and stored (protected from light) to ensure their integrity, and transported to the laboratory for further analysis.

2.2.3. Sample Preparation

Once received at the laboratory, samples were classified, coded, and logged. Samples collected at different depths were mixed to form a single composite sample. Each composite sample was spread out on a polyethylene plate and then left to air-dry in a dust- and smoke-free area to avoid any possible contamination. During air-drying, the clods and aggregates were pulverized using a mortar and pestle to reduce particle size. The ground and homogenized samples were then sieved through a 2 mm sieve (Fritsch®, Test Sieve). After sieving, the passings and rejects were homogenized once again, placed in plastic jars, and weighed.

2.3. Physical and Chemical Characterization

2.3.1. Physical Analysis

The physical parameters sought in peat differ according to the paradigm under which each study is approached. In this study, six (6) physical parameters were analyzed: density, moisture content, volatile matter content, volatile matter index, ash content, calorific value. All analyses were performed on the particle size fraction < 2 mm.

1) Bulk density

Bulk density (d) was determined by direct calculation. This technique involves taking a sample of dry peat of specified mass (m) and introducing it into a graduated cylinder containing a specified initial volume of water (V_i), then measuring the final volume of water obtained (V_f). The volume of the peat sample (V) is determined by the difference between the volume of water V_f and V_i. The density is then calculated by [26]:

$$d = \frac{m[\mathrm{g}]}{V\left[\mathrm{cm}^3\right]} \quad (1)$$

with: m: mass of peat sample (g); V: volume of peat sample (cm^3) and d: peat bulk density ($\mathrm{g/cm}^3$).

2) Humidity

The moisture content (H) of a solid is obtained from the weight loss of a sample after heating in an oven at 105˚C for 24 hours, and is given by the relationship [27]:

$$H = \frac{M_{wet} - M_{dry}}{M_{wet}} \times 100 \quad (2)$$

with: H: moisture content (%); M_{wet}: wet sample mass and M_{dry}: mass obtained after heating at 105˚C.

3) Volatile matter content

The volatile matter content (M_v) of a fuel guarantees its flammability. According to the NF1985 standard [26]. To assess M_v, the same sample used to determine moisture content is heated in a muffle furnace to a temperature of up to 550˚C. The M_v is then determined by the mass loss during heating according to the relationship [28]:

$$M_v = \frac{M_{105} - M_{505}}{M_{dry}} \times 100 \tag{3}$$

with: M_v: volatile matter content (%); M_{105}: mass obtained after heating at 105˚C; M_{505}: mass obtained after heating at 505˚C and M_{dry}: sample mass.

The volatile matter index was deduced using the relationship [27]:

$$I_{Mv} = \frac{M_v}{100 - H} \tag{4}$$

with: I_{MV}: volatile matter index; M_v: volatile matter content (%) and H: humidity (%).

4) Ash content

The protocol for assessing ash content (T_c) is almost identical to that for volatile matter content. The difference lies in the fact that, in this case, the crucible is placed in the furnace at 950˚C without being covered. The weight loss of the sample represents the T_c. This parameter is determined by equation [25]:

$$T_c = 100 * \frac{m_2 - m_3}{m_2 - m_1} \tag{5}$$

with: m_1: empty crucible mass (g); m_2: mass of crucible + mass of sample before heating (g); m_3: crucible mass + sample mass after heating (g) and T_c: ash content (%).

5) Calorific value

Calorific value (CV) is the amount of energy released in the form of heat by complete combustion. It is generally expressed in kWh/kg or MJ/kg, and sometimes in kcal/kg, and in two forms: lower calorific value (LCV) and gross calorific value (GCV). The LCV is the total amount of heat released per kg of fuel during combustion, not including condensation of the water vapour contained in the flue gases, while the GCV is the amount of energy released by complete combustion, the water vapour being assumed to be condensed and the heat recovered. The GCV is therefore equal to the sum of the LCV and the latent heat in the water vapour produced by combustion. Two methods are available for estimating LCV: experimental measurement and empirical measurement. In this study, only the LCV was determined. Due to lack of equipment to determine it experimentally, the empirical measurement given by CASSAN's formula [26] was used:

$$\mathrm{LCV} = 80 * (100 - C) \tag{6}$$

WITH LCV: lower calorific value (kcal/kg) and C: carbon content (%).

2.3.2. Chemical Analysis

1) pH

The pH was measured using the pH meter from the peat suspension in mineral water in the proportions of 1:2.5 for 15 minutes.

2) Organic carbon

The organic carbon (C_{org}) or fixed carbon content was evaluated by the dry method (by combustion) according to the relationship [27]:

$$C_{org} = 100 - \left(T_c + M_v\right) \tag{7}$$

with: T_c: ash content (%); M_v: volatile matter content (%) and C_{org}: organic carbon content (%).

3) Organic matter content

The organic matter content (Mo) was obtained by measuring the carbon content. The ratio MO/carbon is estimated to be approximately constant at 1.72. This implies that MO is estimated by the relationship [27]:

$$\text{Mo} = 1.72 * C_{org} \tag{8}$$

with: C_{org}: Organic carbon content (%) and Mo: Organic matter content (%).

2.4. Data Processing and Statistical Analysis

2.4.1. Data Processing

Data processing and laboratory analysis results were used to map the study area, establish the stratigraphic logs of the sample holes, and determine a number of statistical parameters.

1) Mapping

Mapping consisted mainly in the spatial location and estimation of the surface area of the study zone, as well as the interpolation of the distribution of the physical and chemical parameters assessed over the extent of this zone. This interpolation was carried out using QGIS and Google Earth software. The interpolation method used in this study is the inverse distance method [29].

2) Stratigraphic logs of sample holes

The stratigraphic logs of the sample holes were established using SURFER 11 software [30]. The aim was to show the succession of different horizons of varying natures according to peat composition.

3) Statistical parameters

The various statistical parameters evaluated in this study are average, standard deviation, variance and range [29]. The analysis of variance for the linear regression was carried out successively by pair between the laboratory analysis variables, using Fisher's test. This was used to check whether one parameter varies linearly as a function of another.

2.4.2. Statistical Analysis of Data

This step consisted in analyzing the variance (ANOVA) of the regression of the peat's physico-chemical parameters. This analysis verified the relationships (linear or quadratic) between a dependent or target variable (Y) and an independent or explanatory variable (X), which would be expressed by a zero slope (β_1 = 0) in the case of a linear regression or the zero coefficient of the second-degree monomial (β_2 = 0) and/or the first-degree monomial (β_1 = 0), in the case of a quadratic regression. Quadratic regression was performed in the case of poor fit by linear regression. Thus, the models generated are given by the equations:

$$Y = \beta_1 x + \beta_0 \quad \text{(linear regression)} \tag{9}$$

$$Y = \beta_1 x^2 + \beta_1 x + \beta_0 \quad \text{(quadratic regression)} \tag{10}$$

This ANOVA of the regression was carried out using a program developed in the python programming language, which provided the Fisher test values of the regression (F_{obs}), the value of the coefficient of determination R^2, the regression model and the graphical representation of the regression model.

For linear regression, a single value was obtained, while for quadratic regression, two test values were obtained. This second value of Fisher's test justifies the need to move to a higher degree of regression in the event of a poor fit by the linear regression and if the difference between these two regressions is significant.

The Fisher test values obtained by the program were then compared with critical values (F_{cr}) obtained from the Fisher distribution table (at the 5% threshold) with degrees of freedom $\upsilon_1 = 1$ and $\upsilon_2 = n - 1$ (for linear regression), $\upsilon_1 = 2$ and $\upsilon_2 = n - 3$ for the first test value and $\upsilon_1 = 1$ and $\upsilon_2 = n - 3$ for the second test value (quadratic regression) (n being the number of observations).

If (F_{obs}) > F_{cr}, it cannot be said that, at the 5% threshold, the dependent variable Y does not have a linear or quadratic relationship with the independent variable X.

3. Results

3.1. Description of the Study Area

The delimitation of the study area using QGIS software indicates that the Nangongo peat bog occupies an area estimated at around 1 km^2. Vegetation is unevenly distributed across the bog, with the presence of a particular species of tall trees towards the central part of the bog, which is generally flooded. However, the less-flooded edges of the bog, with their mineral soil rich in humus derived from low-level plant decomposition, are ideal for the growth of a wide range of plant species. The bog's water supply comes exclusively from meteoric waters. This suggests that it is an ombrogenic or ombrotrophic bog [1] [31] [32]. The mode of formation of this peat bog is entourbement by paludification, a phenomenon common in geographical depressions and wet basins, as highlighted by Karhola [33]. Traces of peat exploitation (for energy purposes) have been observed mainly in the north-eastern and eastern parts. The main crops grown here are onions and cabbage.

3.2. Description of Peat Samples

A visual description of the samples taken revealed variations in certain physical characteristics, such as coloration, degree of decomposition and the presence of materials other than peat, depending on depth. The average sampling depth was 114.56 cm, with maximum and minimum depths of 130 cm and 80 cm respectively.

Observations of the peat bog stratification indicate a profile divided into three layers where the degree of decomposition increases with depth. According to the Von post scale [25] used to assess the degree of peat decomposition, the stratigraphic profile is as follows: a fibric layer at the surface with low organic matter decomposition, followed by a sapric layer with advanced organic matter decomposition and finally a humic layer at depth with pronounced organic matter decomposition.

Decomposition is more pronounced at greater depths because the conditions required for peat accumulation are more favorable. As depth increases, the higher the temperature, the more the peat becomes flooded and the lower the oxygen concentration. These are the conditions favorable to peat encroachment, as highlighted in the literature [6] [32].

As for peat coloration, observations have shown that it varies with depth and with the type of vegetation observed around the sampling point.

The general tendency was to observe a blackish peat color, but some brown, gray, and reddish colorations were also identified.

The presence of clay in the peat samples collected would be due to the alteration and drainage of sediments from geological formations (shale and sandstone) adjacent to this environment, as suggested by Halsey [34].

At average depth, the volume of peat in the study area is estimated at 1,145,600 m^3, where fibric peat occupies 650,000 m^3, sapric peat 450,000 m^3 and the remaining volume is humic peat.

3.3. Physical Characteristics of the Peat Bog

Table 1 shows the results obtained from the physical analysis of the samples. The average moisture content is 27.3%. The maximum and minimum values are 56.9% and 16% respectively. The median value is 23.6%. This parameter also has a range of 32.2. The variance and standard deviation of this parameter are 117.9 and 12.7 respectively.

Generally, above-average moisture values (>27.3%) were measured in the central, eastern, and south-western parts of the bog, while below-average values (<27.3%) were measured in the north-eastern and southern parts (**Figure 3**).

The mean density is 1.0. According to the data analyses, the variance, range, and standard deviation are estimated at 10^{-5}; 10^{-2}; 4×10^{-3} respectively.

The average ash content of the samples was 30.2%, ranging from 2.4% to 87.8% (**Table 1**). The median value was 26.9%. The measured variance, standard deviation and range are 864.9; 28.1; 85.4 respectively.

High ash concentrations (>35%) were measured in samples from the central part of the bog, and below-average concentrations (<30.2%) around the central

Table 1. Results of physical analysis of peat samples.

Station	Humidity (%)	Ash content (%)	Volatile matter content (%)	Volatile matter Index	Calorificvalue (kcal/kg)
2	56.9	80.2	18.8	0.4	1584.2
3	26.0	39.1	55.6	0.8	4869.6
4	23.6	29.7	67.0	0.9	5626.8
5	19,5	7.0	75,6	0.9	7442.8
6	16.6	3.9	86.8	1.0	7686.2
7	27.1	27.3	62.4	0.9	5814.6
8	19.9	26.9	72.6	0.9	5846.2
9	16.0	2.4	84.5	1.0	7806.8
10	20.4	87.8	7.8	0.1	975.6
12	49.2	3.9	84.7	1.7	7684.7
13	25.1	23.9	73.7	1.0	6087.8
Average	**27.3**	**30.2**	**62.7**	**0.9**	**5584.1**
Maximum	**56.9**	**87.8**	**86.8**	**1.7**	**7806.8**
Minimum	**16.0**	**2.4**	**7.8**	**0.1**	**975.6**
Median	**23.6**	**26.9**	**72.6**	**0.9**	**5846.2**

part and in the southern and northern parts (Figure 4).

The results of volatile matter analysis in the samples show that the average value is 62.7%, ranging from 7.8% to 86.8% (Table 1) with a range of 79. The variance and standard deviation are 693.6 and 25.1 respectively.

Very high volatile matter concentrations (>70%) were analyzed in samples from the north-west and south-east parts of the bog, while very low concentrations (<30%) were found in samples from the central and south-west parts (Figure 5).

Calorific average value, which was evaluated according to the CASSAN relationship presented in the materials and methods section, is 5584.1 kcal/kg and this parameter varies between 975.6 to 7806.8 kcal/kg (Table 1). The range of this parameter is 6831.2. The median observed in the analyses is 5846.2 kcal/kg. The variance and standard deviation are 5535246.2 and 2243.2 respectively.

The north-western and south-eastern parts of the bog have peat samples with a high calorific value (>3000 kcal/kg), compared with the central part, which has peat with a low calorific value (<1000 kcal/kg) (Figure 6).

3.4. Chemical Characteristics of Peat Bog

Table 2 shows the results obtained from the chemical analysis of the samples. The average pH value was 3.9, with a maximum value of 4.2, a minimum value of 3.5 and a median of 4.0 (Table 2). This parameter had a variance of 0.05, a

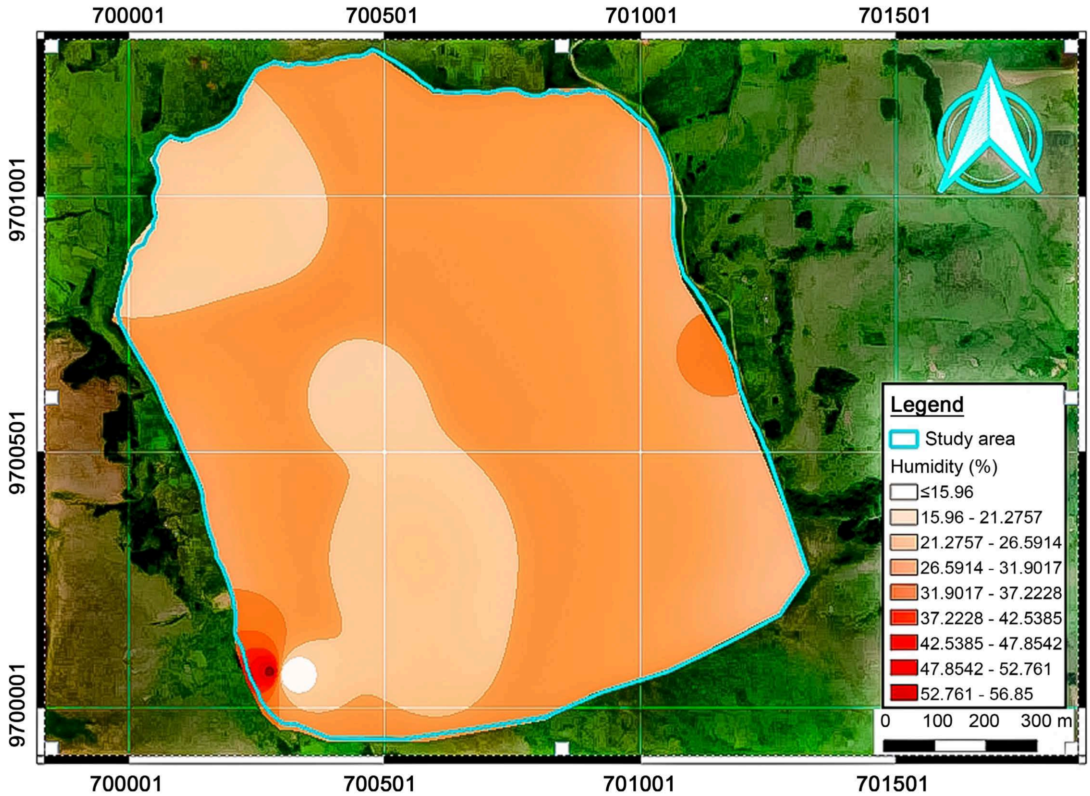


Figure 3. Humidity variation over the study area.

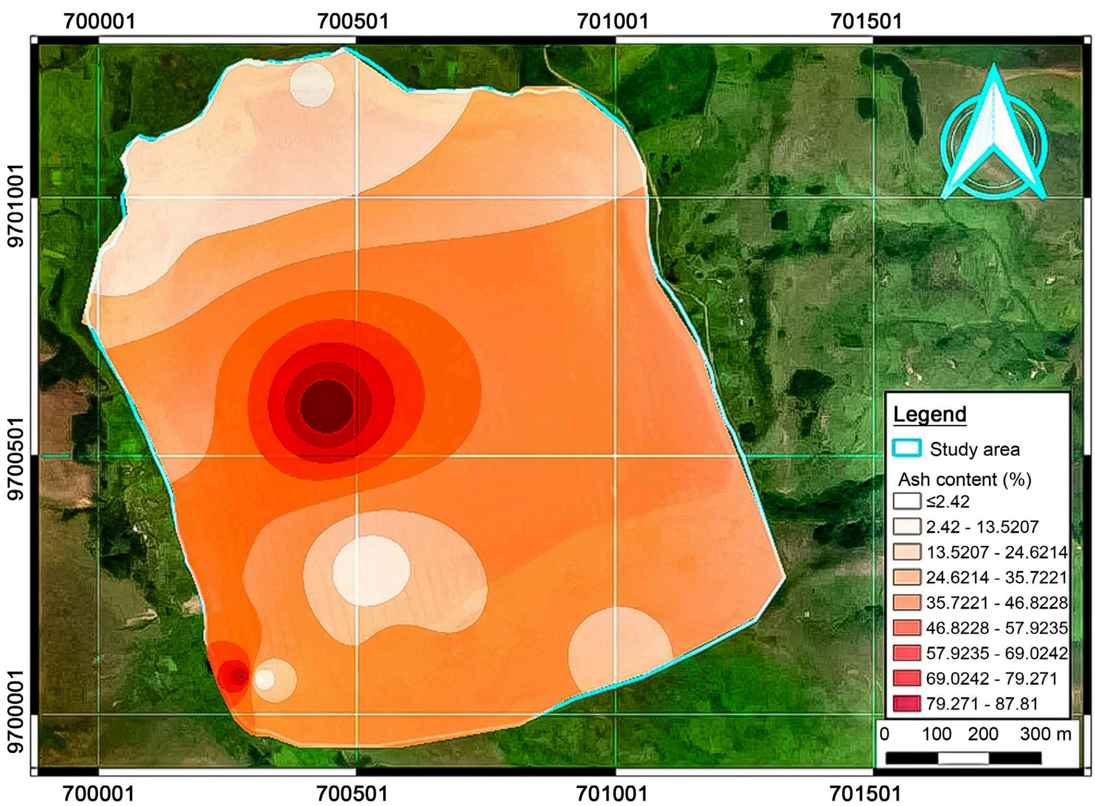


Figure 4. Ash content variation over the study area.

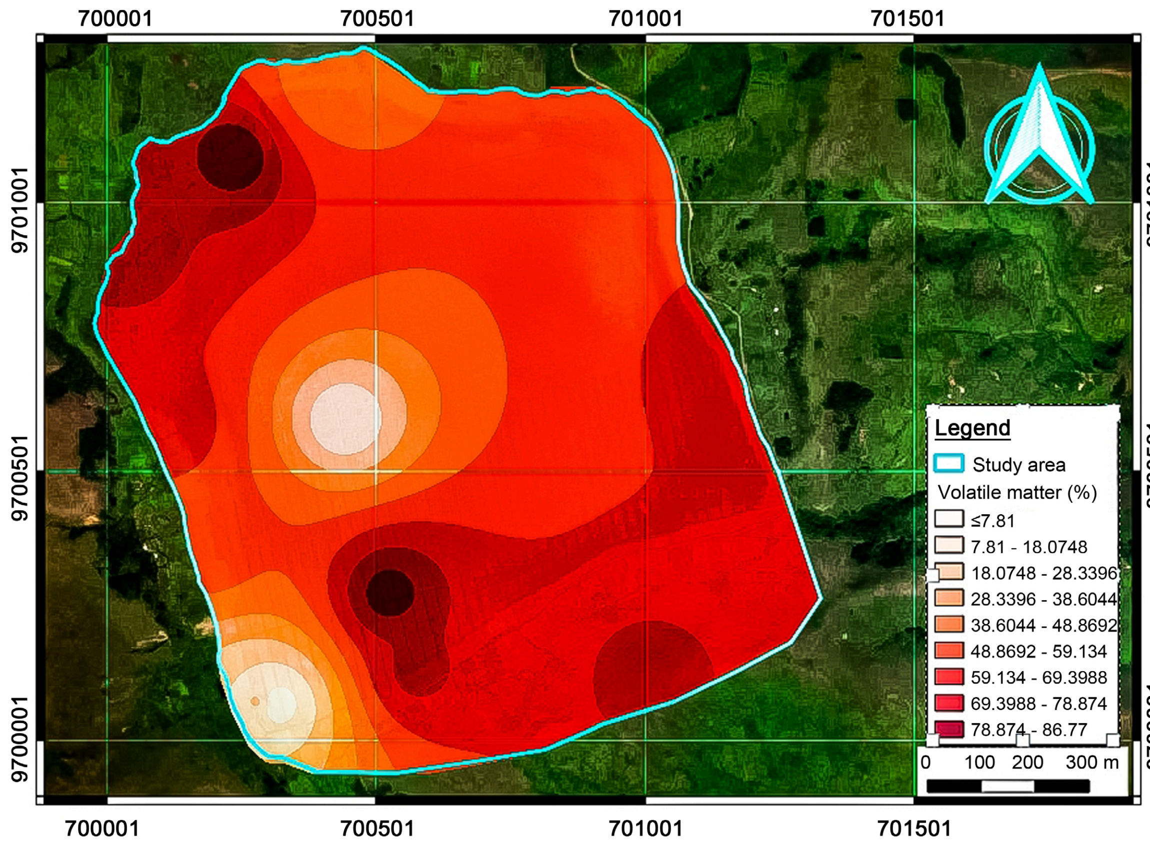


Figure 5. Variation of volatile matter content over the study area.

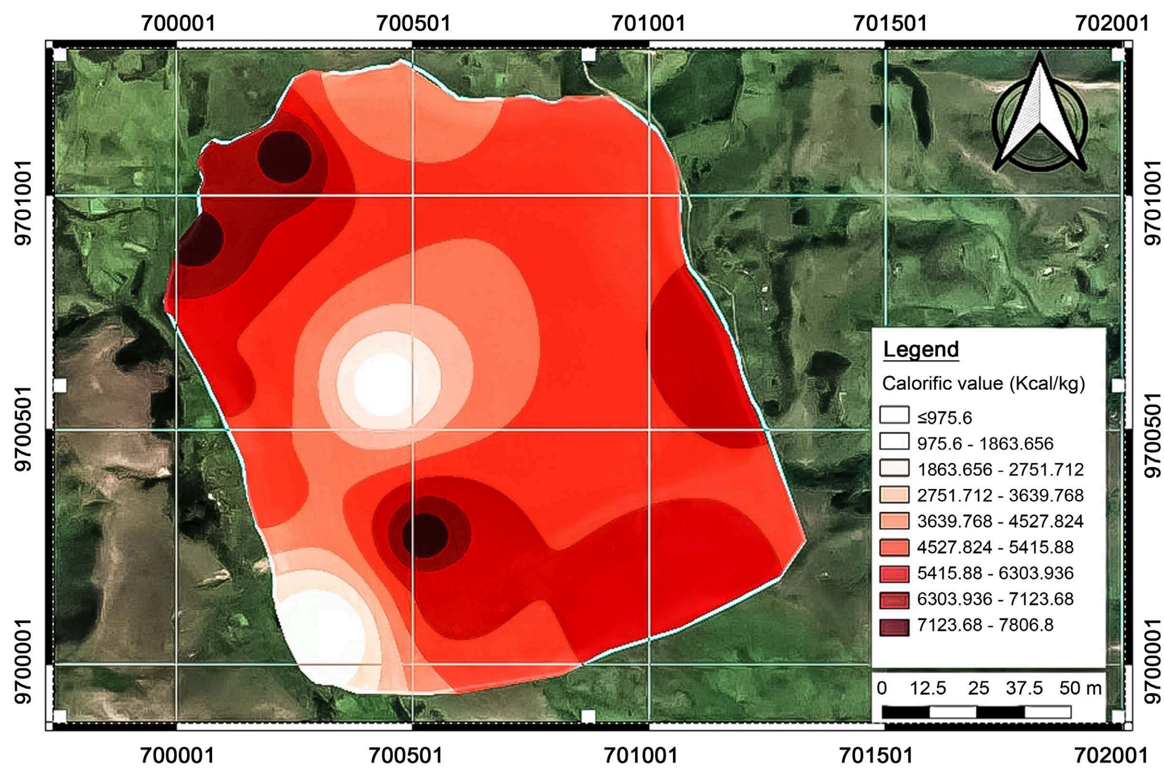


Figure 6. Variation of calorific value over the study area.

standard deviation of 0.2 and a range of 0.7.

This parameter showed values below the minimum (<3.5) for samples from the northern and south-western parts of the bog. However, values above 3.5 were measured in samples from the central, western, eastern, and south-eastern parts (**Figure 7**). The bog is therefore acidic.

Carbon content had an average value of 7.0%, with a maximum of 17.4%, a minimum of 0.5% and a median of 5.3% (**Table 2**). The measured variance and standard deviation indicated values of 30.2 and 5.2 respectively. The range of this parameter is 16.9. Above-average concentrations (>7) were measured on samples from the north-western, eastern, and near-central parts of the bog, and concentrations < 2.0% for samples generally located in the southern part of the bog (**Figure 8**). According to the results of the organic matter content calculation obtained with equation 8 presented in the materials and methods section, the observed average of this parameter is 12.2%, with a maximum value of 30%, a minimum value of 0.8% and a median of 9.1% (**Table 2**). This parameter also has a variance of 89.3, a standard deviation of 9.0 and a range of 29.1.

As with carbon content, above-average concentrations (>12.2%) in organic matter are found in the north-western, eastern, and near-central parts of the bog, and concentrations < 4.0% are generally found in the southern part (**Figure 9**).

3.5. Statistical Analysis of Data

According to Fisher's table at the 5% threshold, the critical values of the test are

Table 2. Chemical analysis results of samples.

Station	pH	Carbon content (%)	Organicmatter content (%)
2	3.9	1.0	1.7
3	4.2	5.3	9.1
4	4.0	3.4	5.8
5	3.6	17.4	30.0
6	3.8	9.3	16.0
7	4.1	10.2	17.6
8	4.0	0.5	0.8
9	3.7	13.0	22.4
10	4.1	3.4	7.6
12	3.5	11.3	19.5
13	4.0	2.4	4.2
Average	**3.9**	**7.0**	**12.2**
Maximum	**4.2**	**17.4**	**30.0**
Minimum	**3.5**	**0.5**	**0.8**
Median	**4.0**	**5.3**	**9.1**

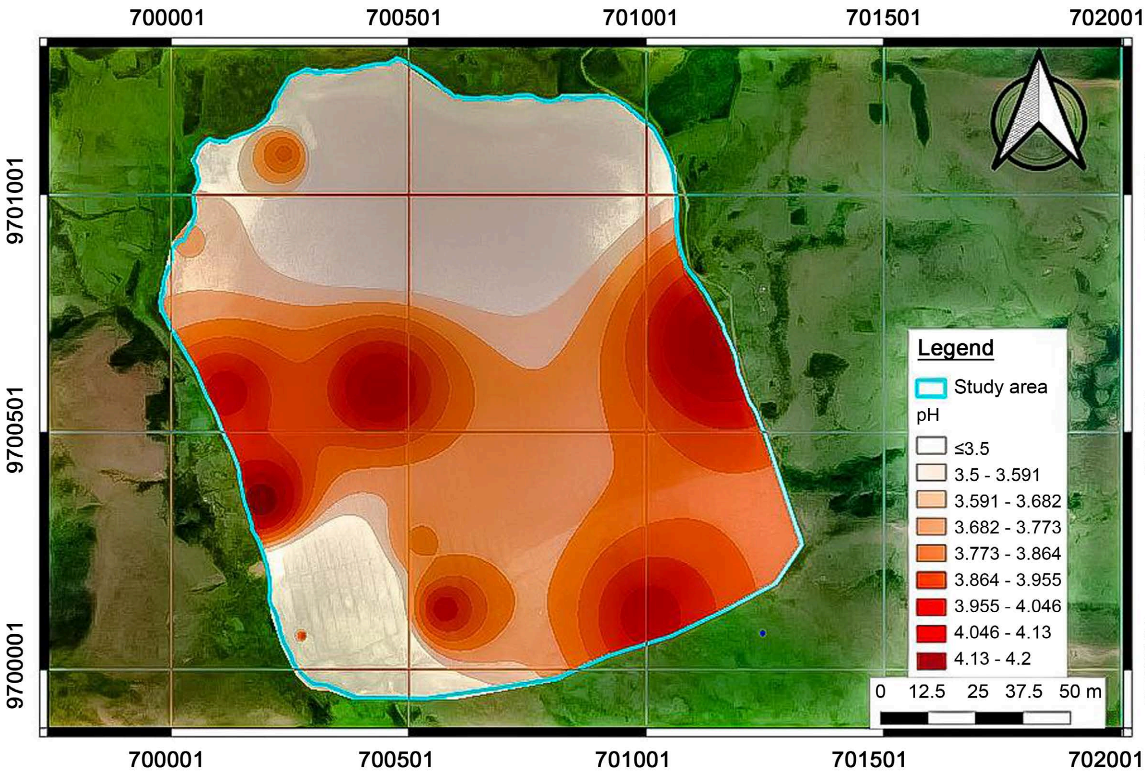


Figure 7. pH variation in the study area.

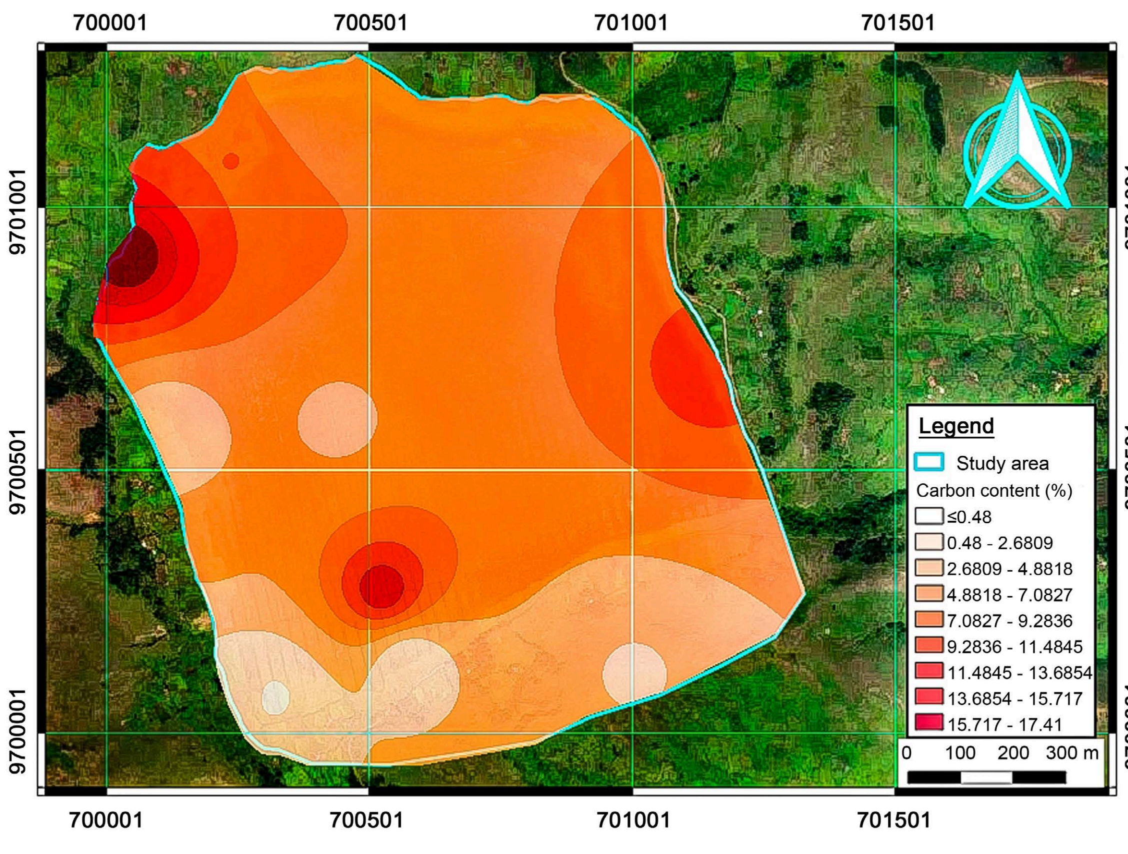


Figure 8. Carbon content variation in the study area.

given by $F_{cr} = 5.32$ ($\upsilon_1 = 1$ and $\upsilon_2 = 8$) for linear regression and $F_{cr}(1) = 5.14$ ($\upsilon_1 = 2$ and $\upsilon_2 = 6$) and $F_{cr}(2) = 5.99$ ($\upsilon_1 = 1$ and $\upsilon_2 = 6$) for quadratic regression. After analysis of the results obtained, the observed values of Fisher's law test and the coefficients of determination obtained are shown in the graphs presented in Figure 10. Statistical analyses show that, at the 5% threshold, calorific value maintains an increasing linear relationship with volatile matter content ($R^2 = 0.86$; $F_{obs} > F_{cr}$) (Figure 10(d)), carbon content ($R^2 = 0.50$; $F_{obs} > F_{cr}$) (Figure 10(b)) and organic matter content ($R^2 = 0.50$; $F_{obs} > F_{cr}$) (Figure 10(c)). Calorific value also has a decreasing linear relationship with ash content ($R^2 = 1$; $F_{obs} > F_{cr}$) (Figure 10(a)).

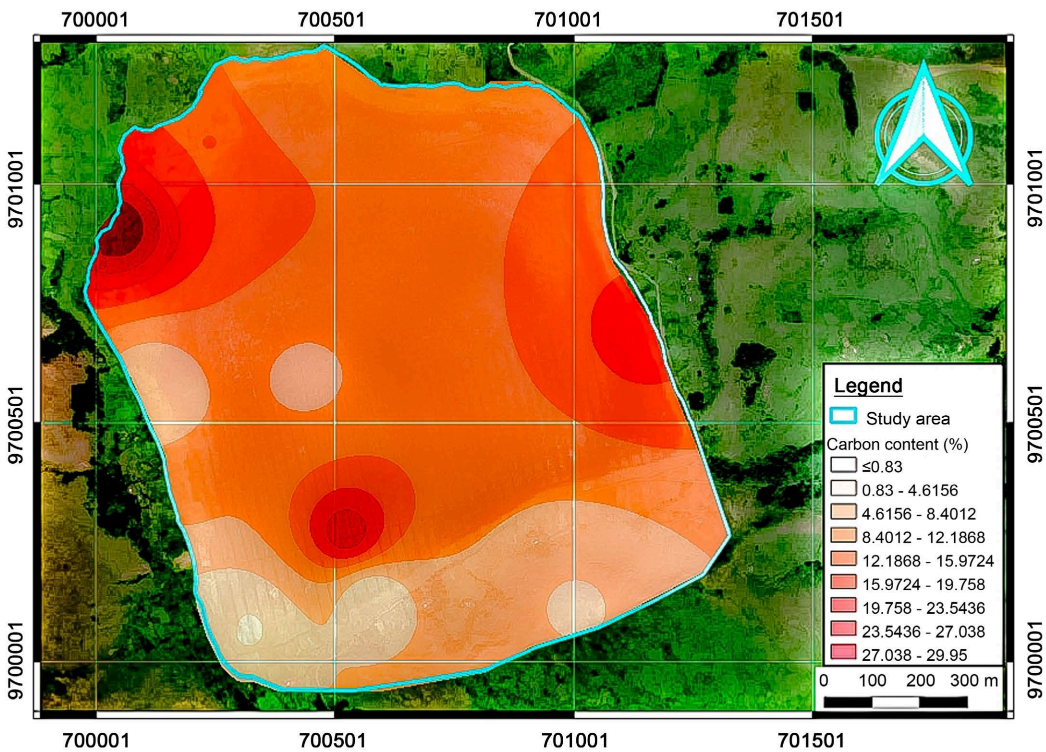
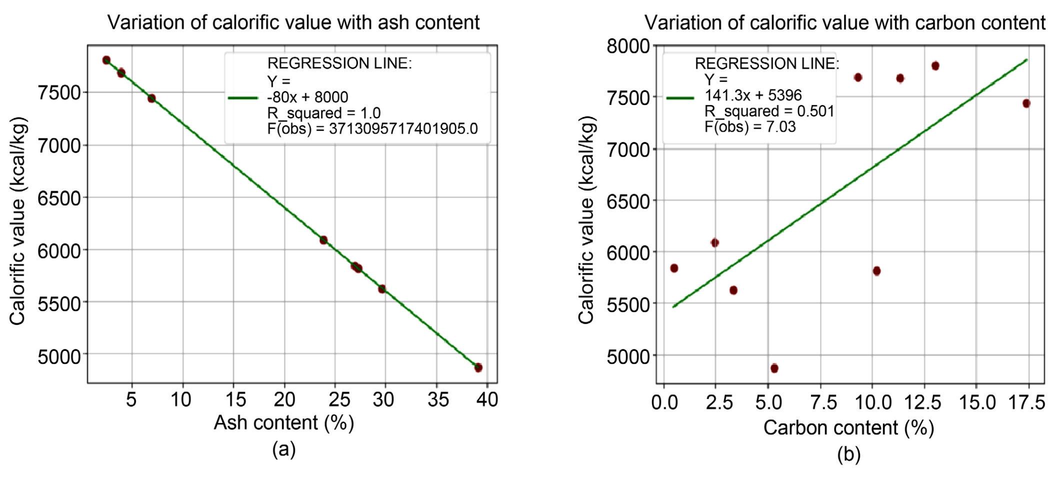


Figure 9. Variation of organic matter content in the study area.



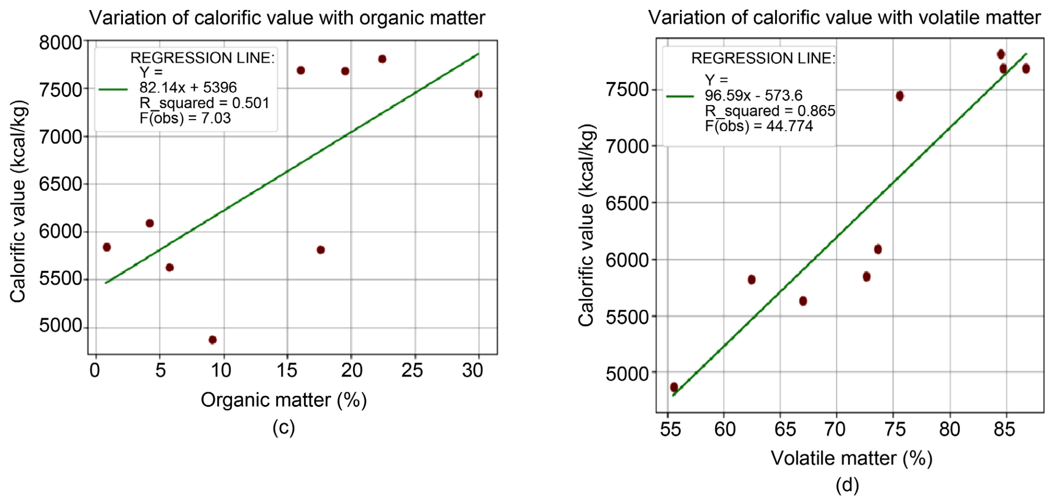


Figure 10. Relationships between some peat variables.

4. Conclusions

The main objective of this study was to determine the physico-chemical characteristics of the Nangongo peat bog with a view to its use in the production of briquettes for fuel.

To achieve this objective, the methodology used consisted in presenting the study area, planning the sampling, and carrying out the physical and chemical analysis of the peat samples in the laboratory.

The Nangongo peat bog is an ombrotrophic peat bog. The peat stratification comprises three layers: fibric peat on the surface, sapric peat in the middle and humic peat at the bottom.

The results obtained show that the physico-chemical characteristics of this peat bog are like those of other peat bogs presented in the literature. As for as physical characteristics, the average moisture content is 27.3%, the density has an average of 1.0, the results of volatile matter analysis show that the average value is 62.7%, the ash content of the samples has an average value of 30.2%. The calorific value of this peat is of the order of 5584 kcal/kg and is higher than the limit value (4464 kcal/g) required by certain authors. These results lead to the preliminary conclusion that peat from the Nangongo peat bog could be used in briquette manufacture.

Concerning chemical analysis results, the average pH value was 3.9, the carbon content had an average value of 7.0% and, according to the results of the organic matter content calculation, the average observed of this parameter was 12.2%. The result obtained indicates that %, classifying it as a mature peat bog.

Conflicts of Interest

The authors declare no conflicts of interest.

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