EFFECT OF ORGANIC CARBON ON THE MODIFICATION OF SOIL FERTILITY IN THE NORTH-EAST OF THE DEMOCRATIC REPUBLIC OF CONGO

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Abstract. *The soil represents the large reservoir of carbon biomass of the continental biosphere containing approximately twice the stock of atmospheric carbon; However, knowledge of its stock on agricultural soil is necessary to quantify its agricultural fertility in its relationship to nitrogen. Thus, a few indicators were verified, in particular agricultural practice (incineration and non-incineration), hydrogen potential (pH), total organic matter, total carbon content of surface horizons for slices of 0-10 Cm, 10 -20Cm, 20-30Cm. The following results were obtained :The global average of earthworms in the intertropical zone is 25 individuals per square meter (25U/m²) while the use of the practice of incineration annihilates this population for the slice of the soil of 0-10 cm depth; The hydrogen potential (pH) shows an overall average of 4.04 which ranks it among the very acidic soils of the region. This acidity is due to the agricultural practice which removes the vegetation cover, and nature of the source rock but also to the excess of precipitation. Total organic matter is found in an average of 17.17 percent in the soils of Haut-Uélé while the total organic carbon rate is on average 9 percent. Following the effects of climatic conditions (rainfall, temperature, etc.) in the Uélé Basin, the organic part of this ferralsols tends to be lost in erosions (internal and external)*

Keywords: *Organic, Carbon, Fertility*

INTRODUCTION

Organic matter is one of the indicators of the fertility of a land when evaluating the effects of a cropping system by playing an important role in the properties of the soil and determines the conservation and plant productivity of this resource.

The existence of close relationships between the organic matter, i.e. organic carbon, contents of the surface horizons of ferruginous and ferrallitic soils and their physical, chemical and biological properties is observed in the modification of fertility. agricultural soils in the North-East of the DRCongo.

Thus, the analysis of some Chemical, Physical and Biological parameters of the soil of the region of the Uélé basin was made respectively for the pH, Organic carbon. Knowledge of the amount of organic carbon, the count of earthworms under two agricultural practices (Slash and burn agriculture with a long fallow period) when counting earthworms from 0 to 20 cm deep and for the pH, the slices of the soil from 0-10Cm, 10-20Cm were analyzed.

Following the effects of climatic conditions (rainfall, temperature, etc.) in the Uélé Basin, the organic part of this ferralsols tends to be lost in erosions (internal and external)

Moreover, the sensitivity of a soil to erosion is linked, among other things, to the organic matter content of the surface horizon and the quantity of clay.

Human activities participate in the modification of the environmental conditions, more precisely of the individual soil, which leads to the disturbance of the soil ecosystem and

accelerates the degradation of natural resources, the effects of which have a severe impact on the living conditions of the populations.

According to Okoba (2005) cited by Nabahungu (2012) considers human pressure as a major driving force of these degradation processes following deforestation, the reduction or absence of fallow periods, the cultivation of sometimes marginal lands with very steep slopes formerly reserved for grazing and afforestation, and with the absence or low addition of amendments for the maintenance and restoration of soil fertility.

MATERIALS AND METHODS

Geographic location

Our study was conducted in the city of Isiro; at the site of the University of Uélé, at GOSSAMU located at PK 3 on the Watsa axis.

Our experiment took place in the concession of the University of Uélé from April 30 to August 30, 2020. The geographical coordinates of our Study Area are as follows:

- North latitude: 2° 78'98
- East longitude: 27° 64' 48
- Altitude of 749m

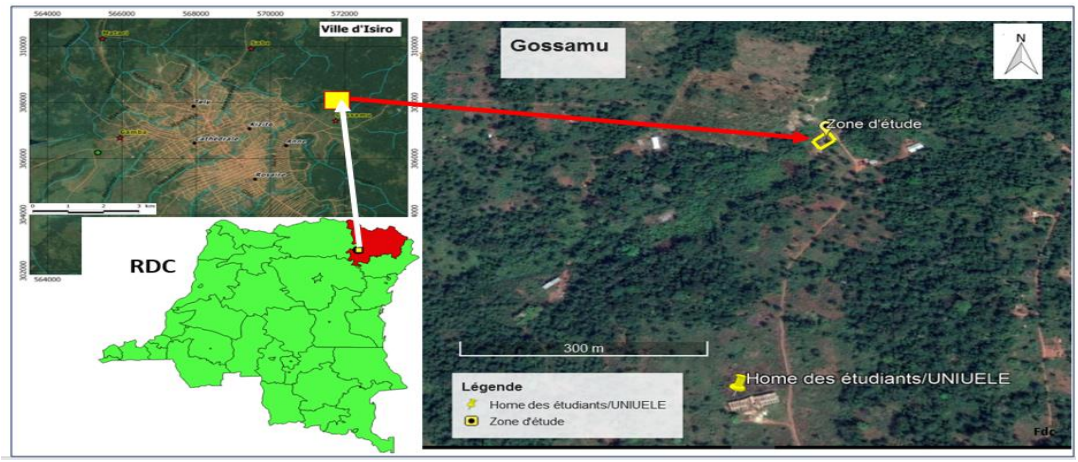

Fig. 1: Map of the City of Isiro in Haut-Uélé in the Democratic Republic of Congo
Source : Established by ourselves using Google earth software, January 23, 2021

Weather

Haut-Uélé generally has an Am climate type. According to the simplified classification of the German Wladimir Koppen, the Am type constitutes a climate of transition between the Equatorial climate of the Af type and the tropical climate with the marked dry season of type **Aw.** (Kakuni, 2017).

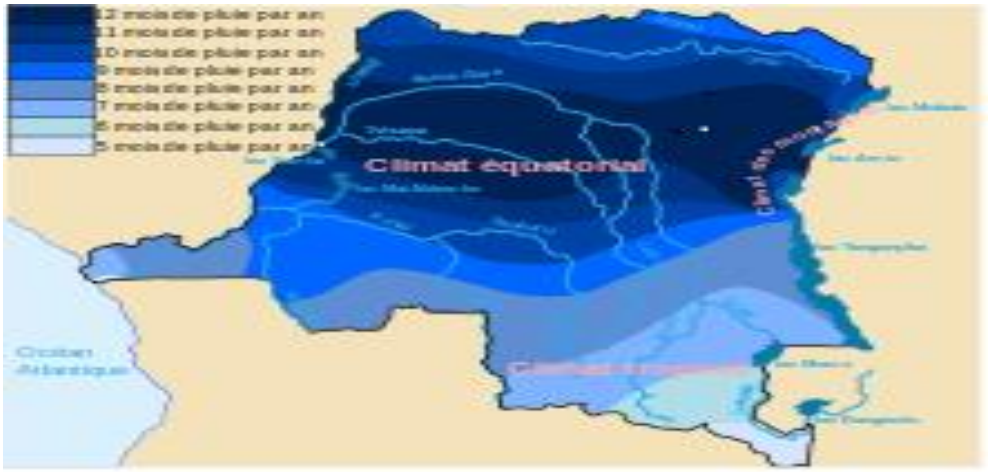

Fig. 2: Climat map of Democratic Republic of Congo

Haut-Uélé has two seasons which connect at four intervals:

- A great dry season which starts from November 15 to March 15;
- A small dry season which goes from June 15 to July 15;
- A short rainy season from July 15 to November 15 ;
- A long rainy season starting from March 15 to June 15.

For several years, these seasonal intervals have experienced disturbances linked to agricultural practice (bush fire, carbonization, the use of chlorofluorocarbons from hydrocarbon by-products, etc.), which strongly influences the climatic disturbance as a result of the disturbance of the agricultural calendar (Amelo, 2009)

The meteorological data related to our experimental period are presented in table 1

Table 1.

Climatic data from the experimental period

MONTH	**MARCH**	**APRIL**	**MAY**	**JUNE**	**JULY**	**AUGUST**
Average temperature in degrees (c)	26.0	24.6	24.5	25.6	25.3	23.7
Maximum precipitation in mm	148.0	255.0	348.6	461.5	647.3	687.5
Average relative humidity	36.6	43.7	74.1	86.0	102.6	104.1

Sources: Meteorological data from Isiro/Matari airport (2020).

Soils and vegetation

According to the INEAC classification, the soil of Isiro is placed in the order of tropical ferralsols, under the order of Kaolisols and large group of Hygro-xero-Kaolisols but also Hydro-Kaolisols because of lowlands (Kakuni , 2016).

This soil is reputed to be acid because of the abundant rainfall and also the nature of the parent rock, which is poor in exchangeable bases.

Like the soils of tropical regions, the soil of the Uélé Basin where the City of Isiro is located is generally characterized by total hydrolysis as a process of ferrallitization or

laterization and the formation of armor due to the accumulation of iron. with hardening (Kakuni, 2016).

Thus, given the low activity of the tropical clays of which the soil of Isiro is a part, the contribution of organic matter which represents a very large part of the storage capacity of the elements is therefore essential.

Three types of materials were used for our work, these are in particular:

- Biological material;
- Technical materials;
- Chemical Materials.

A field experiment, bibliography study as well as practical knowledge of the environment helped us to constitute this present work with regard to the few informative data to scientifically prove what we had written.

1. **For agricultural practice,**

Two plots were the subject of our experiment, one that we incinerated and the other without incineration, and in each plot we had counted the earthworms on two slices of soil including 0 to 10 cm and 10 to 20 cm of depth for counting.

Fig. 3. Burning of the front lands plowing

2. **pH**

Was determined from samples taken in three slices of soil for three characteristic profiles of our study area. After conditioning, they were brought to the laboratory for analysis using an electrode pH meter.

3. **Determination of soil total organic matter (TOM) by the loss-on-ignition method**

This method consists in first driving back the humidity (water) of the soil in the oven (at 105°C) for 24 hours giving the dry weight of the soil (WS) then placing it in the oven at a temperature of 600°C. C approximately 10g of soil previously dried (WS) for calcination for 16 hours according to the AFNOR standard of 1996.

4. **Obtaining the total organic carbon content (TOC).**

It was deduced from the total organic matter content (MOT) obtained by dividing it by a coefficient of 1.724 (D.BAIZE et al, 1995). This conversion factor comes from the fact that in 100% of MOT, there is on average 58% of total organic carbon (TOC). (KOMBELE F., 2004).

Analysis of results and application used

A manual analysis of statistics on the average and the percentage were carried out for the few tables but also a google eath application was used for the establishment of the map of our study area

RESULTS AND DISCUSSIONS

a) agricultural practice

It is necessary to identify the main cropping systems in the region and analyze the sustainability of their productivity. A study that we carried out on the peasant agricultural practice which uses the bush fire as the only factor facilitating the opening of the land after the mowing and the felling of the high forests.

Table 2.

The count of earthworms in Gosamu in the North-East of the DRCongo

Depth	Plot not incinerated		Cremated parcel		**∑X**	**Average**
0 – 10cm	70	63	0	0	133	33.25
10 – 20cm	18	13	2	5	38	9.5
∑X	88	76	2	5	171	42.75
Average	44	38	1	2.5	85.5	
%	51.4	44.4	1.1	2.9		24.9

In this study, we understood that the agricultural practice of biomass incineration would strongly contribute to the negative modification of the biological fertility of the soils of the Uélé basin, especially in the first 10 centimeters of the soil where no earthworms is observed; But, at the 20th centimeter, the difference between the two agricultural practices is glaring in the destruction of at least 96 percent of the living beings that regenerate the fertility of the soil.

The ash which remains for a short period modifies the pH temporarily and then it runs off during the rainy season or through irrigation.

b) Hydrogen potential (pH)

This key parameter of agricultural production in the humid tropical climate is the basis of agricultural nomadism leading to the destruction of the soil cover each year, thus leaving the soil available to natural factors such as insolation, temperature but also and above all the precipitation of rainwater causes erosion (internal and external) and increases the acidity of surface soils as specified in Table 3: below.

Table 3.

The soil pH of Gosamu in the North-East of the DRCongo

Depth	P1	P2	P3	**∑X**	**Average**
0 – 10cm	3.9	3.6	3.6	11.1	3.70
10 – 20cm _	4.2	3.6	3.6	11.4	3.80
20 – 30cm	4.5	4.5	4.9	13.9	4.63
∑X	12.6	11.7	12.1	36.4	
Average	4.2	3.9	4		4.04

∑X: Sum of the pH of the three slices per profile

It emerges from this table no.3 that the average pH is around 4 but it evolves in an increasing way as one descends in depth, from the first slice of the soil, one has an average of pH 3.7; The second horizon has a pH of 3.80 and the third horizon has a pH of 4.63 which means that the soil of the city of Isiro and its surroundings (Gosamu) is extremely acidic.

According to Philippe DUCHAUFOUR, (1988) the state of the absorbing complex and its possible modifications by ion exchange, are of considerable importance insofar as they govern through the intermediary of the pH, the biological activity, the structure and the fertility. soil mineral.

From the above, pH has effects on nutrient exchangeability, solubility and availability

c) ORGANIC MATTER AND CARBON

The results relating to the rate of organic matter in our study area are recorded in Table 4 below.

Table 4.

Content in organic matter (%)

Depth	REPETITION			TOTAL	AVERAGE
	I	II	III		
0 – 10cm	16.5	16.2	16.3	49.0	16.3
10 – 20cm _	15.1	13.9	13.6	42.6	14.2
20 – 30cm	25.1	19.1	18.8	63.0	21.0
TOTAL	56.7	49.2	48.7	154.6	51.53
AVERAGE	18.9	16.4	16.2	51.53	17.17

From this table, we see that the overall average rate of organic matter on the soil of our experimental site is 17.17 percent

The percentage of organic matter leads us to the percentage of carbon sequestered in each species.

d) ORGANIC CARBON RATES

The organic carbon content was deducted from the organic matter content and the results are recorded in table 5 below.

Table 5.

Content in organic carbon (%)

Depth	REPETITION			TOTAL	AVERAGE
	I	II	III		
0 – 10cm	9.57	9.39	9.45	28.41	9.47
10 – 20cm	8.75	8.06	7.88	24.69	8.23
20 – 30cm	14.55	11.07	10.09	36.52	12.18
TOTAL	32.87	28.52	27.42	108.93	36.31
AVERAGE	10.95	9.50	9.14	27.2	9.04

Reading the results of Table 5 above shows us that the average rate of total organic carbon is 9.04

CONCLUSIONS

This study, which focuses on the influence of organic matter on the modification of soil fertility indicators in the North-East of the DRCongo, was carried out in this humid intertropical zone of Central Africa with a view to knowing the various factors limiting agricultural production in this zone and thus giving possible answers to those.

A few key parameters were checked, such as the agricultural practice (incineration and non-incineration) of our peasant farmers in order to know the sustainability indicator for the cropping systems, the hydrogen potential (pH), the total organic matter, the in total carbon of surface horizons for slices of 0-10Cm, 10-20Cm, 20-30Cm.

The following results were obtained:

The global average of earthworms in the intertropical zone is 25 individuals per square meter (25U/m²) while the use of the practice of incineration annihilates this population for the slice of the soil of 0-10 cm depth;

The hydrogen potential (pH) shows an overall average of 4.04 which ranks it among the very acidic soils of the region. This acidity is due to the agricultural practice which removes the vegetation cover, and nature of the source rock but also to the excess of precipitation;

Total organic matter is found in an average of 17.17 percent in the soils of Haut-Uélé while the total organic carbon rate is on average 9 percent. Sys.C. (1970) also indicate that the potential for carbon storage by converting agricultural plots into agroforestry plots is very high on a global scale: they estimate that agroforestry systems could store in their aerial biomass 2.1 Gt C/year in tropical zone and 1.9 Gt C/year in the temperate zone.

KOMBELE B. (2004) reports that agroforestry poplars (111 trees/ha), on sandy loam soils at the Guelph experimental station (Ontario, Canada) stored 39 TC/ha over a period of 13 years, of which 25tC stored in the soil (litter and root turn over). If we count the release of carbon through microbial mineralization, the net storage potential for the poplars of this site is 1.65 t C/ha/year. The authors showed that the agroforestry plot produced 4 times more litter than the control without trees. The potential for conversion of cropland to agroforestry in Canada has been estimated at 45.5 million hectares. If carbon fixation is at least 200 Kg/ha/year on this area, then the 20% GHG reduction objective could be achieved solely through agroforestry within 10 to 15 years.

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