



Impact of Anthropization on the Contents Made of Copper and Zinc in the Urban Soils: Case of the Concession of the Airport of Simi-simi in Kisangani in the Province of the Tshopo in RD Congo

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Abstract:

The present survey had like goal to value the impact of Anthropization on the contents made of copper and in zinc of the urban soils in the concession of the airport of Simi-simi suited in the Common Makiso city of Kisangani, Province of the Tshopo in Democratic Republic of Congo. In every substation, the investigatings have been made besides by the polls to the auger or less 60cm of depth. The samples of soil have been appropriated in: 0-10, 10-20, 20-30, 30-40, 40 -50 and 50-60 cm, giving a total of 18 prompt samples thus by substation and 126 prompt samples reduced to 42 composites for all 6 substations as well as the station-reference (witness) that is the concession of the IFA-Yangambi in the PK41 on the Ituri road. The elements traces metallic copper and zinc have been analyzed and have been measured out by the method of ammonium acetate to the atomic absorption spectrophotometer in presence of EDTA to pH7. Middle content made of most elevated copper is of 782,78 µg/g under station of pure and weakest corn that is 328,42µg/g in relation to all other occupations of soil. Middle content made of more elevated zinc in the dense forest (reference) with 62,98±23,57µg/g and weaker in the cassava-peanut substation with 44,59±23,62µg/g by report others occupation of soil studied in our zone of survey. The impacts of anthropisation are negative to the level of zinc, it observes itself so much in the substations that in their respective slices, what means that the activities practiced in the site of the airport of Simi-simi drew on the reserves of their soil made of zinc more that in copper, although in weak quantities that for this last.

Keywords:

impact; anthropization; contents made of copper and zinc; urban soil; airport of simi-simi

I. Introduction

The strong demographic growth that the developing countries and their difficult economic conditions know entails an anarchical and uncontrolled urbanization. This situation is at the origin of the development of various activities of which some pollute the environment. This pollution is often audible to the level of soils, waters and air, components of which depend closely the man's life. therefore, soil constitutes a vital part of the environmental, ecological and agricultural resources that must be to protect for a lasting development and the future generations (Ameh and al, 2014).

The recent research showed that soils in different parts of the world, especially in the urban and industrial zones, contain immensely elevated concentrations of heavy metals (Wei and al, 2010). works concerning the heavy metals began to attract the attention of the scientists because of their no biodegradability, their toxicity, their persistence and their prevalence (Duong and al, 2011). The heavy metals count among the extensively widespread pollutants coming from the activities anthropogenic and, considering the fact that these elements don't deteriorate, can migrate and accumulate in the different components of the natural ecosystems and possibly to be incorporated in the food chain putting thus in danger the health of the populations (Audry and al., 2004).

However, with regard to the pollution by not biodegradable elements as the elements metallic traces (ETMs), soil generally represents a place of accumulation of the contributions past and present anthropogenic. Since the presence of the human societies on earth, the Anthropization of the natural systems never stopped increasing. soil, seen of his/her/its position to the interface of the lithosphere, the biosphere and the atmosphere, occupies a large surface exposed to this anthropisation. It can modify the nature of soil and his/her/its fundamental functions as support of ecosystems, function of exchange and filter, substrata of the plants. This last maintains the balance of the living being and answers their vital needs.

As for most urban surroundings, the city of Kisangani is not saved by the action anthropogenic, especially in the concession of the military airport of Simi-simi of which the historic proves a succession of works to the basis of the construction of the aforesaid airport, works having driven to the contributions of the compaction materials, asphaltting, casting of reinforced concretes... on the one hand, and of the periods of the wars that let the munitions and shells exploded freeing the different elements metallic traces (ETMs) on soil cultivated by the city-dwellers that would impact negatively the human health, on the other hand.

II. Research Methods

2.1 Place of Study

The present research has been achieved in DRC, in the Province of the Tshopo, city of Kisangani, Township Makiso, District Simi-simi, district medical tray on the Munyororo avenue. Our station of survey is an aeronautic concession belonging to the airport of Simi-simi. She/it is limited at the East by the cemetery of six days, to the North by the first avenue Cabin, to the South by the Guest-house and to the west by the Simi-simi district.

2.2 Material

a. Biologic Material

The site of the airport of Simi-simi is constituted of six constituted substations of different occupations (SST1, SST2, SST3, SST4, SST5 and SST6) and the site of reference is a dense forest (FD). These two sites were the subject of our investigating. Thus, the materials that we used in our survey are constituted mainly of the samples of soil appropriated under the occupations of these two sites.

b. Material not Biologic

For the withdrawal of our pedological samples, we used of: Auger, Hammer of pedology, Hoe, Spade, Knife, Sachets, Labels, meter ribbon, GPS and a Machete.

For the analyses of laboratory, we are served of: Vials sized up of 200 and 1000 ml, conical Vials of 125 ml 1 by sample, brown Small bottle of 200 ml plugged, Pipettes to a feature of 5, 10, 15, 25, 50 and 100 ml, analytic Balance to 0,1 mg, Balance of precision to 0,1 g, Hand to powder in plastic, Small bottles of 125 ml to receive the trial hold, to rigid or flexible partitions, closing tightly but except plugs made of rubber, 1 by sample; Filters in Ø plastic 100 mm, Agitator tipper capable to be adjusted to 40 rpm, Papers filters exempt of copper, manganese and zinc (without ash), Centrifuge to speed? 2000 rpm and tubes of 50 ml, pH-meter, atomic absorption Spectrophotometry, Refrigerator and Balance of precision.

2.3 Method of Research

Our device was constituted of a station herself subdivided in 6 substations. Every substation was a parcel carrying a pure culture or of the associated cultures.

In every substation, the investigatings are made besides by the poll to the auger or less 60cm of depth. The samples of soil are appropriated in 6 slices: of 0 to 10, 10-20, 20-30, 30-40, 40 -50 and 50-60 cm is a total of 18 prompt samples by substation and 108 prompt samples for all 6 substations.

The 6 composite samples are kept by substation, either 36 composite samples for the 6 substations and the obtaining of a composite sample will make itself in the same way by mixture of the prompt samples slice of a substation. As for the 6 samples-witnesses, they are constituted by samples of soil appropriated under the dense forest of the concession of the IFA situated to the pk41 routes Ituni, what makes a general total of 42 unsettled and composite samples.

The samples appropriated, labeled are brought to the laboratory of option soil and water of the IFA-Yangambi in Kisangani for the conditioning. We dried our samples to air free and consistent of the grinding and sifting by the sifter of 2 mm of stitch. The gotten fine earth has been submitted to the different analyses.

2.4 Laboratory Analysis

Copper and zinc were determined by the ammonium acetate method in the presence of EDTA at pH7. A method of analysis which normally makes it possible to analyze in addition to these two elements, manganese. But the content of the latter has not been determined for lack of a reagent including manganese acetate.

2.5 Principle of the Method

The extraction of the soluble forms of copper, manganese and zinc is carried out by a mixed solution of ammonium acetate and EDTA at pH 7 in a ratio of test sample to solution equal to 1/10 (m/ v). The determination of the elements present in the extraction solution is carried out by atomic absorption spectrophotometry. This method leads to an estimate of the copper and zinc contents likely to be assimilated by plants. The equipment, the procedure and the mode of expression of the results are given in appendix A of the work.

III. Discussion

3.1 Results Related to Soil Copper Levels

The various results in relation to the copper contents in the soil of the reference station and substations of our study are presented in Table 1 below.

Table 1. The Various Results in Relation to the Copper Contents in the Soil of the Reference Station and Substations of our Study

Slices (cm)	Substations							Moy	Ecty
	MCA	Mp	MAp	PAD	GMM	PA	Fde		
0-10	826,05	678,17	667,47	648,22	894,85	310,31	942	709,58	±211,29
10-20	690,27	817,54	857,78	589,69	613,55	283,04	870,75	674,66	±206,95
20-30	470,5	549,67	659,49	555,65	944,59	288,64	563,58	576,02	±199,08
30-40	233,37	230,81	910,85	432,18	276,03	222,07	418,52	389,12	±246,62
40-50	622,08	320,72	868,55	385,81	404,19	520,13	210,75	476,03	±218,00
50-60	132,51	230,1	732,54	470,16	204,19	346,34	236,78	336,09	±206,23
mean	495,80	471,17	782,78	513,62	556,23	328,42	540,40	526,92	-
SD	±269,93	±247,99	±109,91	±100,53	±314,43	±102,33	±311,98	-	-
CV (%)	54,44	52,63	14,04	19,57	56,53	31,16	57,73	-	-

Remark. Avg: average; Ecty: standard deviation; MCA: cassava-peanut association; Mp: pure cassava; MAp: pure maize; PAD: sweet potato; GMM: Okra-Cassava and Maize association; PA: pasture; Fde: dense forest (reference) and CV: coefficient of variation.

In general, the substations occupied by the crops show average levels and standard deviations in descending order of $782.78 \pm 109.91 \mu\text{g. g}^{-1}$ (pure maize crop) $> 556.23 \pm 314.43 \mu\text{g. g}^{-1}$ (okra-maize and cassava combination) $> 540.40 \pm 311.98 \mu\text{g. g}^{-1}$ (dense forest) $> 513.62 \pm 100.53 \mu\text{g. g}^{-1}$ (sweet potato) $> 495.80 \pm 269.93 \mu\text{g. g}^{-1}$ (cassava-peanut combination) $> 471.17 \pm 247.99 \mu\text{g. g}^{-1}$ (pure cassava) $> 328.42 \pm 102.33 \mu\text{g. g}^{-1}$ (pasture).

These values show that the soils of the substation carrying the pure maize crop have the highest Cu content ($782.78 \mu\text{g. g}^{-1}$), while the lowest is observed in the substation carrying the pasture ($328.42 \mu\text{g. g}^{-1}$) (figure 3). Depending on the slices of the soils studied, we observe that the 50-60cm deep slice indicates the lowest average value ($336.09 \mu\text{g. g}^{-1}$) of the copper content compared to those of the other slices, with the lowest value higher (709.58 g. g^{-1}) in the 0-10 cm depth range as shown in Figure 4 below; this indicates that the copper contents of the soils of these substations are of anthropogenic origin. It is important to specify that the average copper content values observed both in the substations and in all the units are all higher than that of the world average corresponding to the range of 20-30 mg/kg (Sciences Eaux & Territoires, 2019).

The coefficients of variation are greater than 30%, in the pasture substation (31.16%), in the pure cassava substation (52.63%), in the cassava-association substation. groundnut (54.44%), the okra-cassava and maize association substation (56.53%) and the dense forest substation (57.73%). On the other hand, these coefficients are less than 30% in the pure maize substation (14.04%) and in the sweet potato substation (19.57%). This shows the heterogeneity and homogeneity of the data respectively in the two groups.

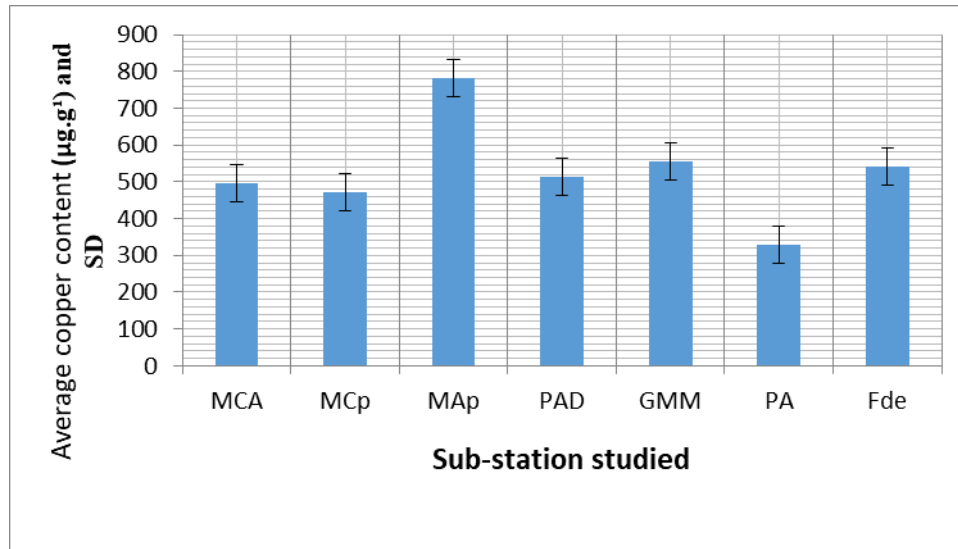
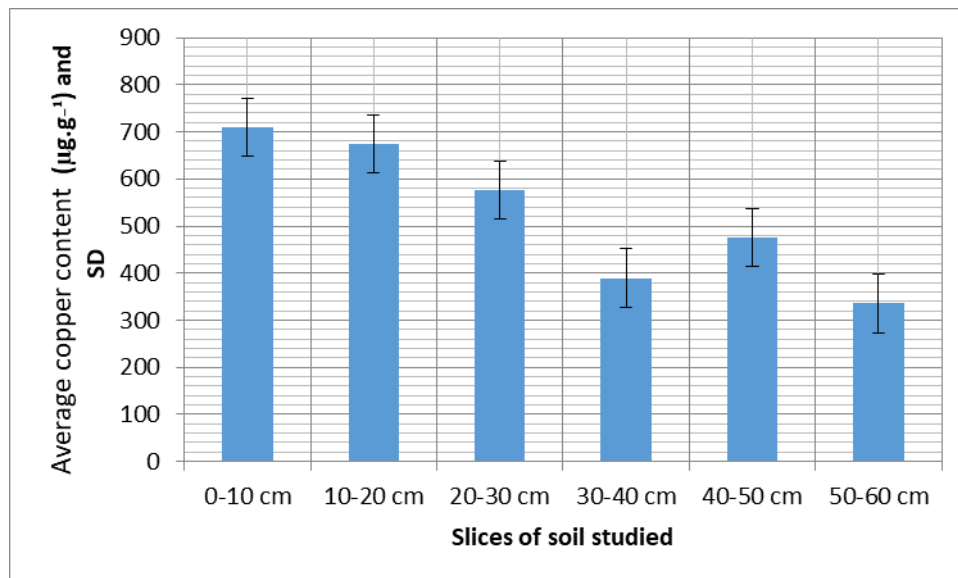


Figure 1. Variations in Average Copper Contents ($\mu\text{g. g}^{-1}$) and Standard Deviations of the Soil of the Substations



3.2 Results Related to Soil Zinc Levels

Table 2 below presents the results in relation to the zinc contents of the soil in the various substations and slices studied.

Table 2. Zinc Contents and Standard Deviations ($\mu\text{g. g}^{-1}$) of the Soil of the Substations and Units Studied

Slices (cm)	Substations							Moy	Ecty
	MCA	Mp	MAp	PAD	GMM	PA	Fde		
0-10	29,18	81,85	78,61	50,31	67,76	35,48	97,69	62,98	±23,57
10-20	81,16	76,06	50,50	46,06	25,87	73,51	65,41	59,80	±18,39
20-30	28,22	55,87	45,41	47,27	53,90	67,36	61,76	51,40	±11,82
30-40	33,13	51,82	50,97	38,22	40,77	34,83	52,86	43,23	±7,84
40-50	73,90	39,92	56,91	82,40	41,62	31,43	70,31	56,64	±18,08
50-60	21,93	66,06	62,86	33,13	41,62	33,13	69,36	46,87	±17,55
Mean	44,59	61,93	57,54	49,57	45,26	45,96	69,57	53,49	-
SD	±23,62	±14,36	±10,90	±15,79	±12,93	±17,45	±13,84	-	-
CV(%)	52,97	23,18	18,94	31,85	28,58	37,96	19,89	-	-

It appears from this table 3 that the dense forest has the average zinc content with its highest standard deviation ($69.57 \pm 13.84 \mu\text{g. g}^{-1}$) followed respectively by pure cassava cultivation ($61.93 \pm 14.36 \mu\text{g.g}^{-1}$), pure maize culture ($57.54 \pm 10.90 \mu\text{g.g}^{-1}$), sweet potato culture ($49.57 \pm 15.79 \mu\text{g.g}^{-1}$), pasture ($45.96 \pm 17.45 \mu\text{g. g}^{-1}$), the Okra-Cassava-Maize association ($45.26 \pm 12.93 \mu\text{g. g}^{-1}$) and the Cassava-Peanut association ($44.59 \pm 23.62 \mu\text{g.g}^{-1}$). The evolution of the fluctuation of the average zinc contents is shown correctly in figure 5 below. The slice results show that the average zinc content decreases from the surface down to 40 cm depth, respectively according to the slices of 0-10 cm, 10-20 cm, 20-30 cm and 30-40 cm. However, the opposite trend is recorded for the last two slices, those of 40-50 cm and 50-60 cm (figure 6), according to the following mathematical scale of magnitudes: ($62.98 \pm 23.57 \mu\text{g. g}^{-1}$ for 0-10cm) > ($59.80 \pm 18.39 \mu\text{g.g}^{-1}$ for 10-20cm) > ($51.40 \pm 11.82 \mu\text{g.g}^{-1}$ for 20-30cm) > ($43.23 \pm 7.84 \mu\text{g.g}^{-1}$ for 30-40cm) < ($56.64 \pm 18.08 \mu\text{g.g}^{-1}$ for 40-50cm) > ($46.87 \pm 17.55 \mu\text{g.g}^{-1}$ for 50-60cm).

Only grazing, sweet potato cultivation and the cassava-peanut association show heterogeneity in their coefficients of variation, while pure cassava cultivation, pure maize, the okra-cassava-maize association and the dense forest on the other hand give homogeneity values recorded in the table above because their coefficients of variation remain below 30%. The expression of the fluctuation of the zinc concentrations in the slices subjected to the study are presented by the elements of figure 3 below.

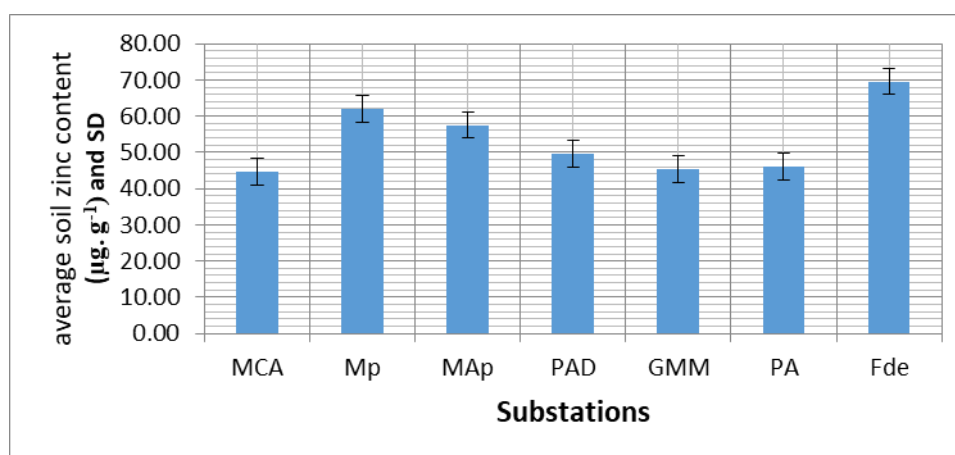


Figure 3. Variations in Average Soil Zinc Levels ($\mu\text{g. g}^{-1}$) and Standard Deviations of Substations

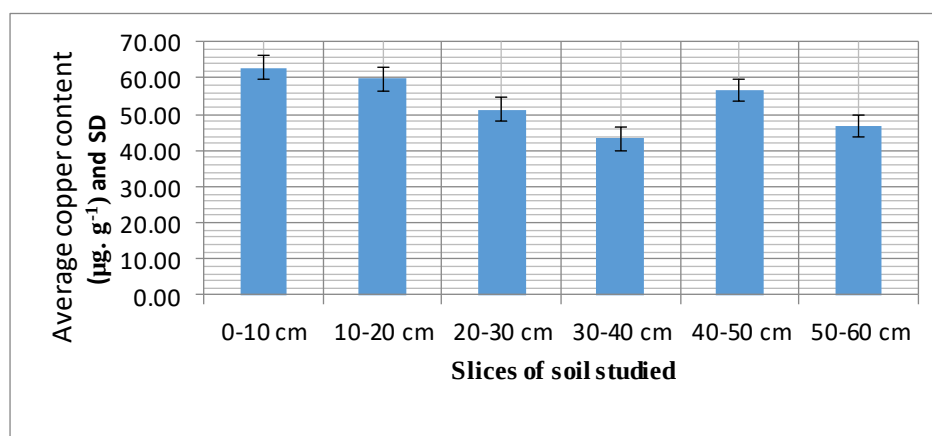


Figure 4. Variations in Average Soil Zinc Content ($\mu\text{g. g}^{-1}$) and Standard Deviations in Slices

3.3 Impacts of Anthropization

a. Compared to Copper

The data relating to the impacts of anthropization on the average copper contents of the soil ($\mu\text{g. g}^{-1}$) of our various substations compared to that of the reference are recorded in the following table 4 with their variations illustrated by the elements Figures 7 and 8 below. At the level of the substations and their slices of soil, these data are obtained by difference between the average soil contents of the substations and their slices with those of the dense forest taken as a reference (control).

Table 4. Impacts of Anthropization of Substations and Soil Sections on the Average Copper Content of their Soil ($\mu\text{g. g}^{-1}$) Compared to the Reference (Control)

Tranches (cm)	Sous-stations						Total
	MCA	Mp	MAp	PAD	GMM	PA	
0-10 Cm	-115,95	-263,83	-274,53	-293,78	-47,15	-631,69	-1626,93
10-20 Cm	-180,48	-53,21	-12,97	-281,06	-257,2	-587,71	-1372,63
20-30Cm	-93,08	-13,91	95,91	-7,93	381,01	-274,94	87,06
30-40Cm	-185,15	-187,71	492,33	13,66	-142,49	-196,45	-205,81
40-50 Cm	411,33	109,97	657,8	175,06	193,44	309,38	1856,98
50-60 Cm	-104,27	-6,68	495,76	233,38	-32,59	109,56	695,16
Total	-267,6	-415,37	1454,3	-160,67	95,02	-1271,85	-566,17

With regard to this table, it should be specified that a negative anthropization impact means that in a substation or its sections, the agricultural and other activities which have been practiced there have drawn on the copper reserves of the soil compared to the witness; a positive impact means that there is enrichment of the soil in place with copper. Remember that in both cases, the situation is potentially dangerous because we do not know whether the quantities of copper exported from the soil by crops are at what critical safety threshold (case of negative impacts), as we also do not know the critical threshold of enrichment of the soil by the various activities developed there.

However, the elements of Table 4 above show that the pure maize cultivation substations and that of the Okra-Cassava-Maize association had a positive impact on the soil reserve in average copper content, justifying the contribution of the agricultural activity affected there, as illustrated in the histograms of Figure 7 below. On the other hand, the cassava-peanut association, pure cassava, sweet potato cultivation, grazing have negatively impacted the soils of the substations that they have colonized by drawing on the copper soil reserve.

These various exports (even copper enrichments) remain high and exceed the world threshold standard (30-40 mg/kg). At this level of research, it is too early to certify whether these high copper exports constitute a danger for human consumption. Therefore, we can finally point out with precision that grazing alone caused the highest copper withdrawal in the substations studied.

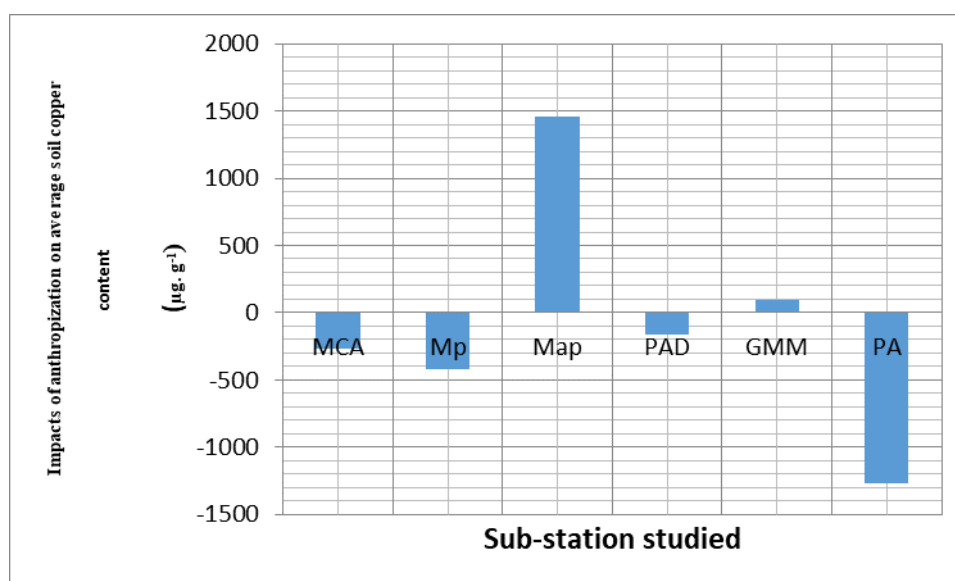


Figure 5. Variations in Anthropization Impacts on Average Soil Copper Levels ($\mu\text{g. g}^{-1}$) of the Substations Studied Compared to those of the Reference (Control)

Regarding the soil slices in the different substations studied, the slices of 0-10cm, 10-20cm and 30-40cm depth present negative anthropization impacts, the greatest negative impact being for slice 0 -10cm. On the other hand, the 20-30cm, 40-50cm and 50-60cm slices show positive anthropization impacts, the greatest positive impact being for the 40-50cm deep slice. These different variations are illustrated by the elements of figure 6 below.

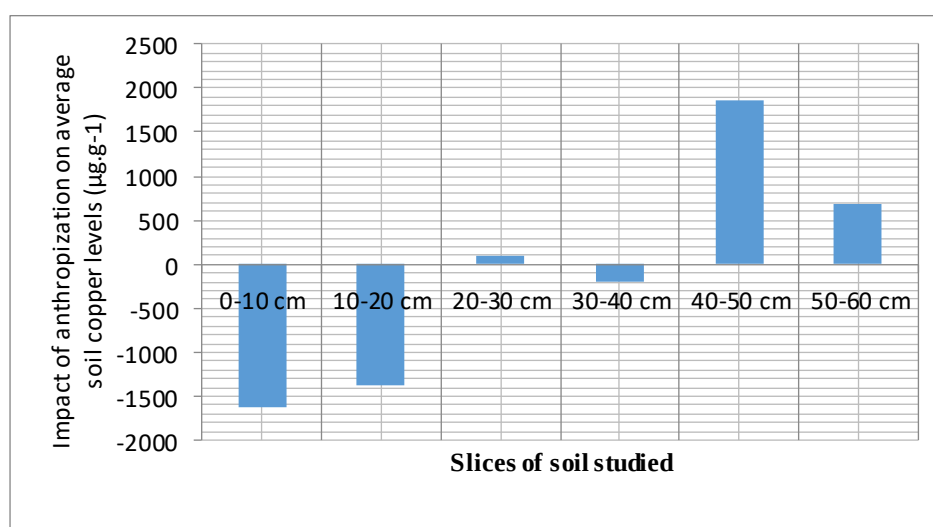


Figure 6. Variations in Anthropization Impacts on the Average Soil Copper Content ($\mu\text{g. g}^{-1}$) of the Soil Slices Studied Compared to those of the Reference (Control)

b. Compared to Zinc

The impacts of anthropization in relation to zinc are recorded in Table 5 with their variations illustrated by the elements of Figures 7 and 8.

Table 5. Compared to Zinc

Tranches (cm)	Substation						Total
	MCA	Mp	Map	PAD	GMM	PA	
0-10	-68,51	-15,84	-19,08	-47,38	-29,93	-62,21	-242,95
10-20	+15,75	+10,65	-14,91	-19,35	-39,54	+8,1	-39,30
20-30	-33,54	-5,89	-16,35	-14,49	-7,86	+5,6	-72,53
30-40	-19,73	-1,04	-1,89	-14,64	-12,09	-18,03	-67,42
40-50	+3,59	-30,39	-13,4	+12,09	-28,69	-38,9	-95,70
50-60	-47,43	-3,3	-6,5	-36,23	-27,74	-38,23	-159,43
Total	-149,87	-45,81	-72,13	-120,00	-145,85	-143,67	-677,33

It emerges from the elements of table 5 above that the impacts of anthropization of the soil at the level of the substations are negative compared to those of the soil of the reference (control). All of these substations drew more zinc from their soil reserves than did the dense forest soil; this is observed in a decreasing way going from the Cassava-Peanut association, then that of Okra-Cassava-Maize, following grazing, then that of sweet potato, which follows the cultivation of pure Maize which gives way to the cultivation of pure cassava, the least exporting in terms of zinc content.

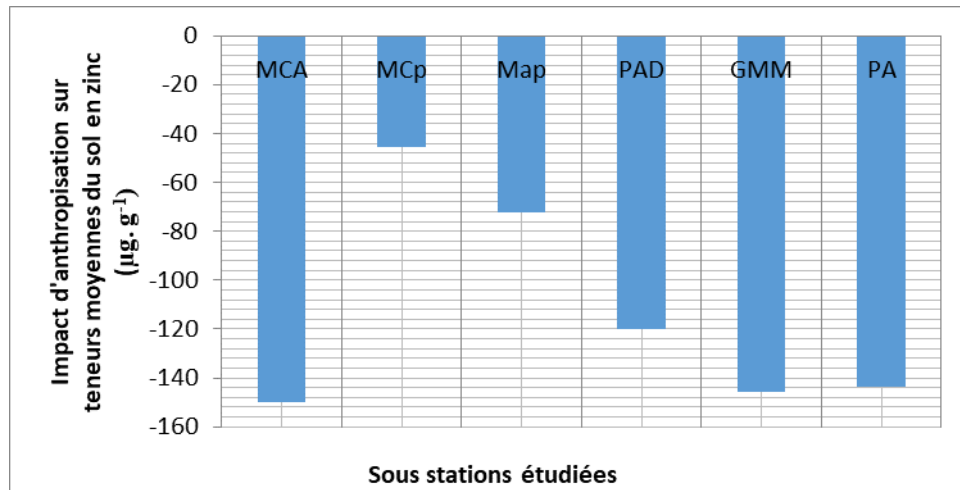


Figure 7. Variations in Anthropization Impacts on Average Soil Zinc Levels ($\mu\text{g. g}^{-1}$) of the Substations Studied Compared to those of the Reference (control)

As for the anthropization impact values of the units as shown in figure 10 below, they are also totally negative both in the soils of the substations and in their respective units. Only the superficial slice (epidermal), therefore that of 0-10 cm, showed a maximum removal of zinc contents; these results revealed a parallelism, compared to the responses of the riparian soils of the neighboring concession of the Bralima plant studied by Moyambongo in 2021.

With regard to a careful and quantified analysis, we can issue the opinion that the crops export more zinc ($-667.33 \mu\text{g. g}^{-1}$) compared to copper ($-566.17 \mu\text{g. g}^{-1}$) in all the substations as well as in the various observed sections of their soil.

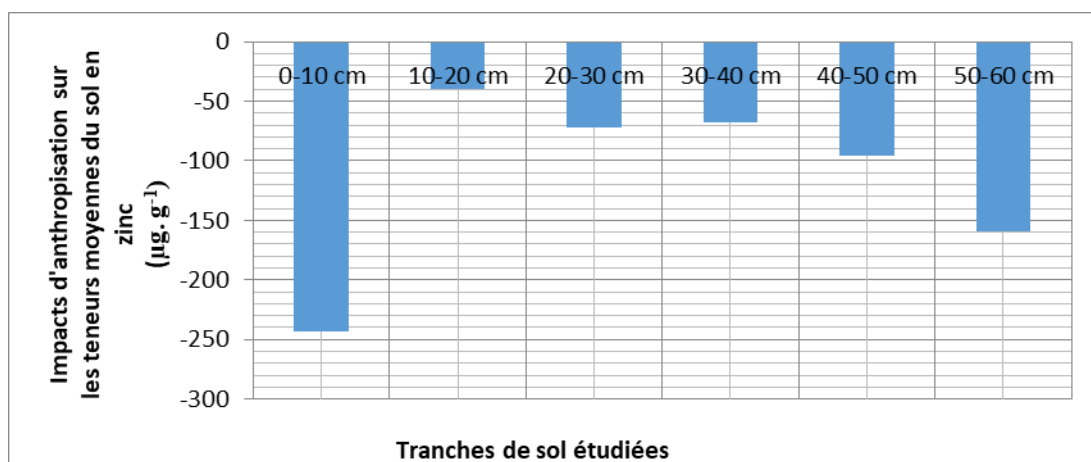


Figure 8. Variations in the Impacts of Anthropization on the Average Zinc Content of the Soil ($\mu\text{g. g}^{-1}$) of the Slices Studied Compared to those of the Reference (Control).

IV. Conclusions

The research which we have the real pleasure of concluding today, has set itself the ultimate objective of measuring the dose of metallic trace elements, in particular copper and zinc in the urban soils of the medical platform, at the level of the Airport. Simi-simi soldier in Kisangani in the Tshopo Province in DR Congo.

After laboratory analysis of soil samples from our study, we obtained the following results:

- The average soil copper content is higher in pure maize substitution with $782.78 \mu\text{g/g}$ and lowest in pasture substitution with $328.42 \mu\text{g/g}$ compared to all other occupations of the ground of our station of the Military Airport of Simi-Simi in Kisangani. These results partly confirm our first hypothesis because the Maize substitution is the only one to have a higher average copper content;
- Depending on the slices of the soils studied, we observe that the 50-60cm deep slice indicates the lowest average value ($336.09 \mu\text{g. g}^{-1}$) of the copper content compared to those of the other slices, with the value the highest ($709.58 \mu\text{g. g}^{-1}$) in the 0-10 cm depth range.
- Given that these contents decrease from surface to depth, this now justifies an anthropogenic impact (an anthropogenic origin of copper) in the soil studied.
- The average zinc content of the soil is higher in the dense forest (reference) with $62.98 \pm 23.57 \mu\text{g/g}$ and lower in the cassava-peanut substitution with $44.59 \pm 23.62 \mu\text{g/g}$ compared to all the other studied land uses of our station surrounding the runway of Simi-simi Airport in Kisangani. These results partially invalidate our first hypothesis because our studied substations do not have high zinc contents compared to our reference station (dense forest);
- The results for the slices show that the average zinc content decreases from the surface down to 40 cm depth. However, the opposite pace is recorded for the last two slices, those of 40-50 cm and 50-60 cm; however, the trend of the grades shows a regression from the surface to the depth slices; these results confirm our second hypothesis which states that slices of 0-10 would present the highest zinc contents compared to other observed slices.
- Although generally higher than those of our reference (dense forest), the average values of the levels observed in our various substations are also higher than the global critical threshold, corresponding to the range of 20-30 mg/kg (Sciences Waters &

Territories, 2019). They confirm our third hypothesis, but at this level of research it is too early to certify whether these levels of ETMs are dangerous for human consumption.

- The impacts of anthropization are negative at the zinc level, this is observed both in the substations and in their respective sections, which means that the activities carried out on the Simi-simi Airport site have drawn on the reserves of their soil in zinc more than in copper, although in lower quantities than for the latter.

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