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Physico-chemical and chemical characterization of soils and water under market gardening cultures in South-West of Benin

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Abstract
The objective of this study is to evaluate the environmental and health consequences of the use of agrochemical inputs in market gardening in South-West Benin. The working methodology is organized in three stages: the prospective visit to identify the target groups to be investigated and the sampling points, a field survey following a reasoned choice involving a sample of 279 people. Finally, sampling campaigns and physicochemical analyzes were carried out. Statistical Analysis System version 9.2 software was used for Analyzes of variance. The mean values were then compared with each other using the Student Newman-Keuls test at the 5% threshold. From our results, it appears that 85% of the people surveyed drill for watering crops. Analyzes show that the intensive use of fertilizers has impacted the quality of cultivated products, soils and water resources.

Keywords: Impacts, agrochemical inputs, market gardening, South-West Benin

1. Introduction

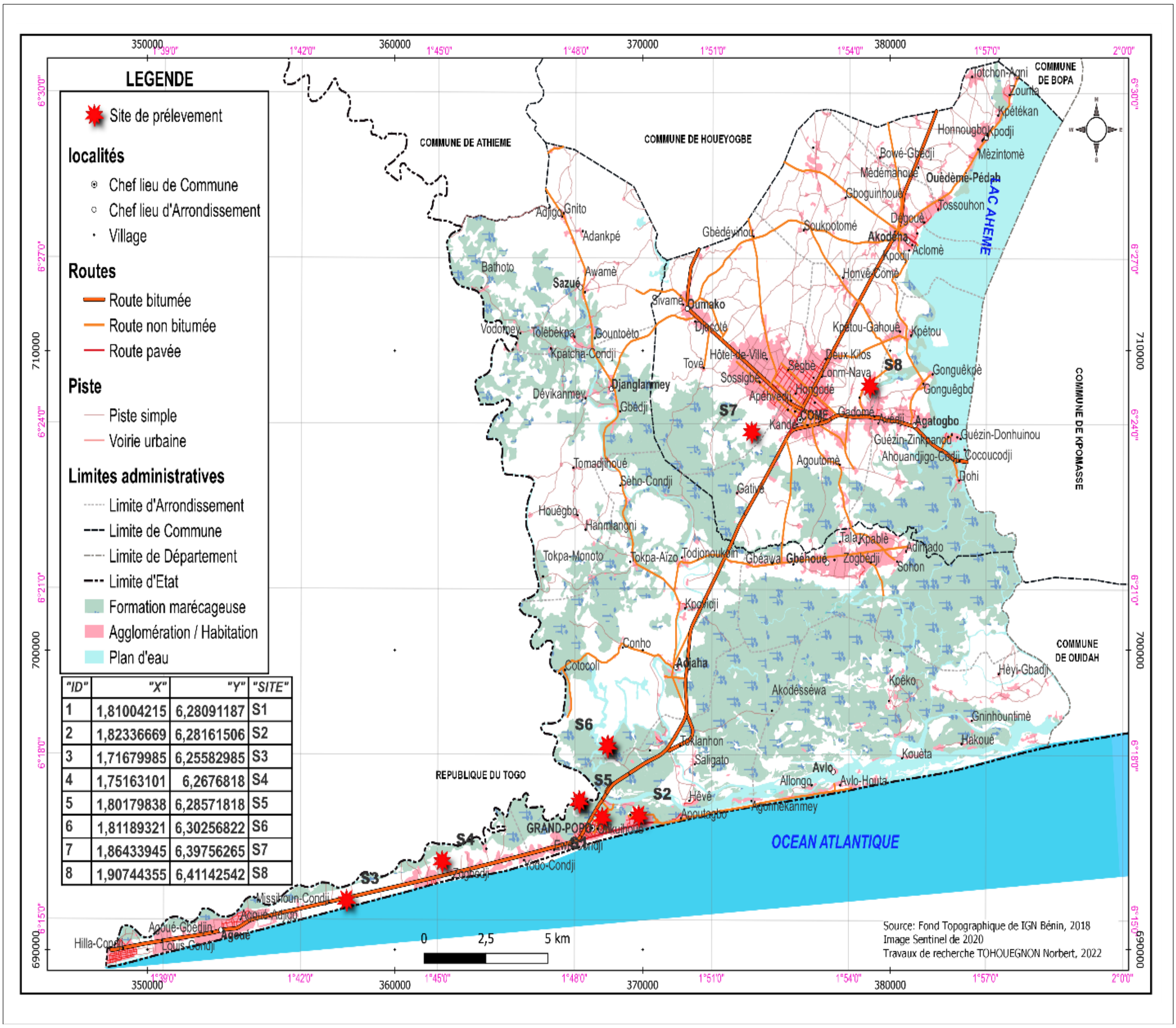
Market gardening is a very prosperous and income-generating activity for market gardeners in the municipalities of Grand-Popo and Comè. It is a sector that contributes to food security and plays a sociologically and economically important role within the Beninese population. National consumption of fresh vegetables is very high and estimated in 2002 at 74,000 tonnes, or approximately 80 kg per person per year (PADAP, 2003, p.7) [1]. Thus, by overexploiting these supposedly rich soils, they become poorer and therefore require a considerable contribution of agricultural inputs in order to maximize yield. These inputs are not without consequences on the health of populations through the foods consumed and on the environment. The objective of this research is to evaluate the consequences of the use of agricultural inputs in market gardening in South-West Benin.

In the communes of Grand-Popo and Comè, market gardening is carried out on the soils of the poor coastal strip which require a significant contribution of agricultural inputs and black soils which are rich in nutrients favorable to production. Thus, 85% of the people surveyed drilled to supply the site with water essential for watering crops. The products grown vary from one site to another taking into account whether or not the soil is rich in substances favorable for their survival. The seeds used are mostly purchased from itinerant traders or those residing in the study area. Different types of fertilizers namely Chemical, Biological, insecticides, fungicides, herbicides are used to treat these crops. In Ivory Coast, Traoré *et al.* (2006) [6] detected contamination of groundwater by organophosphate and organochlorine pesticides in agricultural regions where pesticides are used in cocoa, coffee, rubber, banana and market gardening. Agricultural products intended for consumption can also be contaminated by pesticides. Assogba-Komlan *et al.* (2007) [2] detected residue levels exceeding 0.5µg/g for organochlorines (DDT, Endrin, Heptachlor) in vegetables in southern Benin. During phytosanitary treatments by spraying on foliage, the loss percentages are 10 to 70% to the ground and 30 to 50% to the air (Aubertot *et al.*, 2005, p.10) [3]. When fumigating the soil, 20 to 30% of losses into the air can occur depending on whether or not the application rules are properly followed. Losses to environmental compartments vary depending on the state of crop development, sprayer setting, spray composition and weather conditions.

Pesticides deposited on the ground can transfer through the soil and reach the water table or through runoff and contaminate surface water. Depending on their lifespan, certain pesticides can persist in the soil while others are very quickly degraded by the soil microflora or by chemical hydrolysis and produce metabolites or residues which can also be toxic. In Senegal in the peri-urban area of Niayes where pesticides are used in market gardening, Cissé *et al*. (2003) [4] The sources of supply of chemical compounds are multiple and varied. These include carding, selling to national or international traders who engage in this trade illicitly. The use of chemical fertilizers has repercussions on market gardeners, cultivated products, soils, courses and bodies of water, and the water table.

2. Research environment

2.1 Geographic location: Located in the southwest of Benin, between 6° 15' and 6° 30' north latitude and 1° 39' and 1° 57' east longitude, the Communes of Comè and Grand-Popo are limited to the north by the Commune of Houéyogbé, to the northwest by that of Athiémé and northeast by Bopa; to the south by the Atlantic Ocean; to the east by the Atlantic department and to the west by the Republic of Togo. Figure 1 presents the geographic location of the research sector.



Source: IGN, 2018

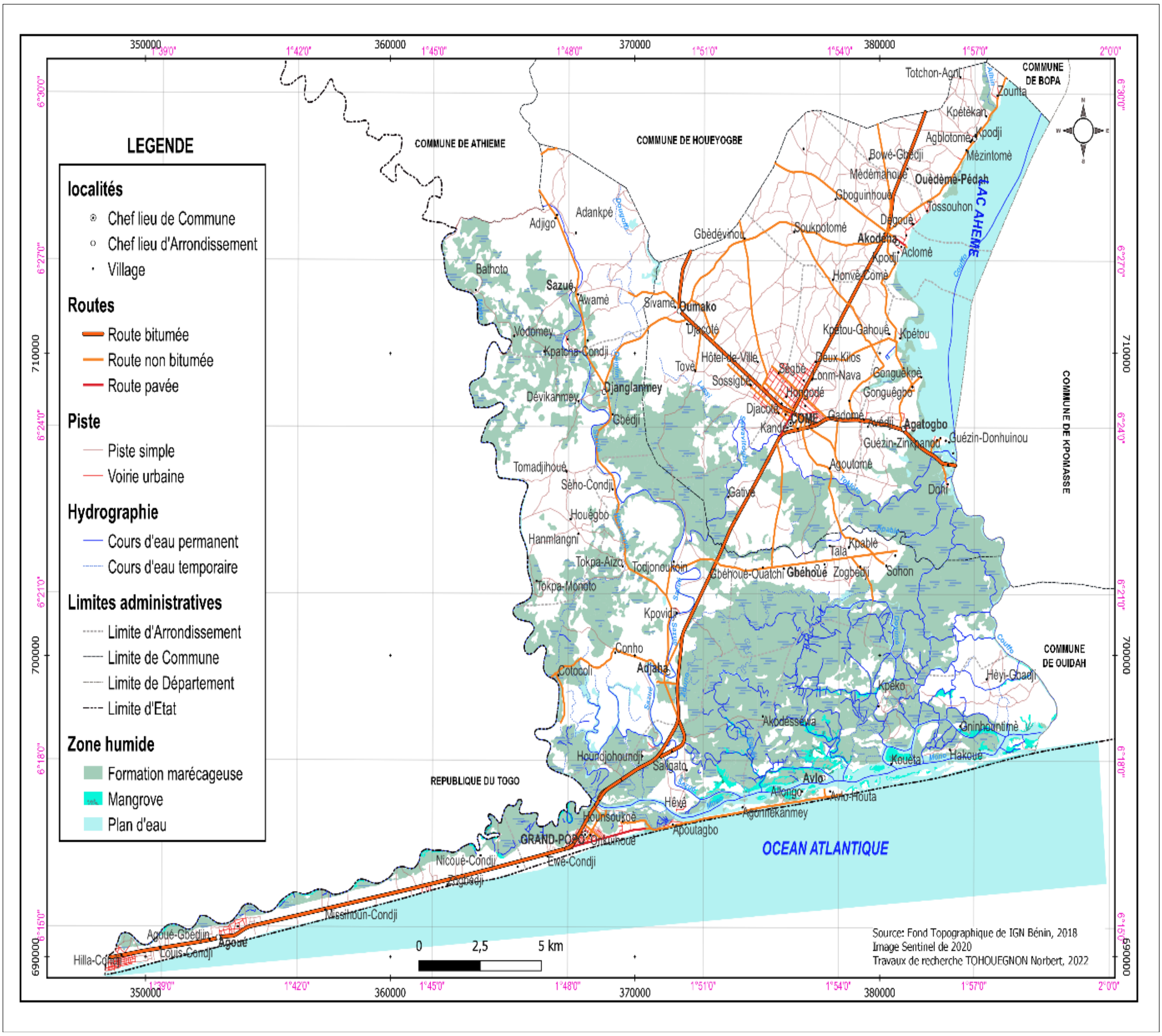
Fig 1: Geographical location of the research sector.

2.2 Hydrographic network

The hydrographic network of the commune of Comè is made up of Lake Ahémé and small bodies of water. Lake Ahémé extends over an area of 78 km² and has its source in the Couffo River. It irrigates the commune on its entire eastern side in the districts of Agatogbo, Akodéha and Ouèdèmè-xwéla, which makes fishing one of the activities of the commune. Among these small plans, we can cite that of Tikpan in Oumako.

The commune of Grand-Popo is watered by a hydrographic network made up of the Mono river, the Grand-Popo lagoon, lakes and marshes. The watercourses that make up the local hydrographic network are: - the Mono River (100 km) which takes its source in the Alédjo Mountains in Atacora in the north-west of Benin and flows in its upper part into Togo before constituting in its lower part the natural border between Benin and Togo from Aplahoué. It has a very irregular tropical regime with large interannual variations and experiences a flood generally located between September - October because it brings back both the waters of the long rainy season received in its upper course and those of the short season received in its lower course. This flood resulted in the flooding observed in Grand-Popo. The river flows into the Atlantic Ocean through a large delta called "Bouche du Roy". From the village of Agbanankin;- Mono communicates with the Grand-Popo lagoon (15 km) which serves as a relay to the Atlantic Ocean.

A series of tributaries and effluents including the Sazoué (the most important), Agogo, Adanwadonmè, etc. whose navigability depends in part on the Mono regime. The Grand-Popo lagoon is 15 km long and opens onto the Aho channel. It receives the waters of the sea and those of the Mono. It also communicates with that (water) of Ouidah (figure 2).



Source: IGN, 2018 and field surveys 2023

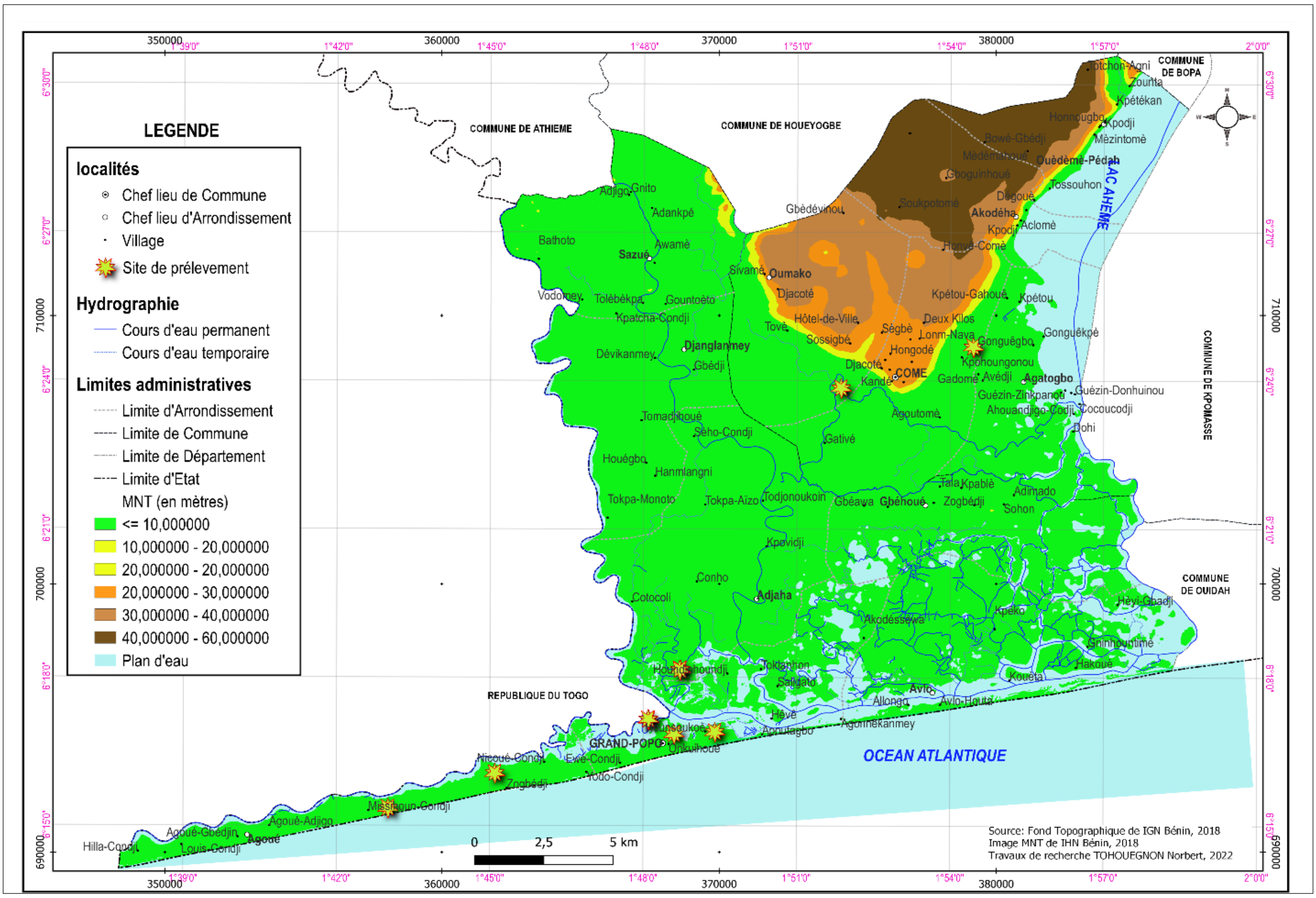
Fig 2: Hydrographic network

2.3 Relief of the communes of Comè and Grand-Popo

The relief of the commune of Comè is made up of a deformed morphological ensemble made of a lateritic plateau from the center to the north. The relief of Grand-Popo is made up of three (03) groups, namely:

-the coast which corresponds to the entire southern part along the sea and goes from Hilla-Condji beyond Gonkô. It is a sandy coastal strip (fluviomarine) that is flat and straight as a whole and whose altitude does not exceed 5m above sea level.

-the marshy areas or low-lying areas and flood-prone areas which cover most of the land, go from the east of Adjaha in the north-east to the Aho channel, estuary of Lake Ahémé. The terminal continental shelf, which covers fine, sandy or sandy-clay formations, often ferruginous, extends from west to north. It covers the regions of Adjaha and goes up towards Gbéhoué. Figure 2 presents the digital model of the municipalities of Grand-Popo and Comè.



Source: IGN, 2018 and field surveys 2023

Fig 3: Relief of the communes of Comè and Grand-Popo

3. Methodological approach

It includes data collection, processing and analysis of the results.

3.1 Collection of data

3.1.1 At the population level

The work methodology is organized in three (3) stages: documentary research, an exploratory study in the research environment, field surveys during which questionnaires were sent to 279 people including 174 market gardeners, 45 workers and 60 traders. Market garden products in Comè and Grand-Popo. To this number are added 33 intermediaries and 32 resource people also following a reasoned choice. The PEIR model made it possible to carry out the analysis in order to highlight the consequences linked to this practice.

3.1.2 Sampling

There are four sampling campaigns, conducted twice each year, once in the dry season and once in the rainy season. During each campaign, samples of soil, groundwater and surface water, market gardening and aquatic organisms were collected. The solid matrices were packaged in aluminum foil, however the liquid matrices such as water were packaged in 2 L glass and/or 1.5 L Possotomè plastic bottles depending on the type of analysis. physico-chemical for which the liquid is intended.

A total of eight (08) water samples were taken from the research environment. As for the soils, there are thirty-two (32) bottles of sediment taken according to the horizons (0-20 cm; 20 cm – 40 cm; 40 cm -60 cm).

3.1.3 Data processing

After sampling, the vials are labeled and stored in a cooler equipped with a cold accumulator to be transported to the laboratory.

Once transported to the Laboratory, the sediment samples were dried in an oven at 65 °C then sieved with a 2mm mesh. The fraction having passed the mesh is taken for cold extraction analyzes such as particle size analyses, pH, exchangeable bases, CEC and assimilable phosphorus. A portion of this fraction is taken to be ground to 0.2 mm for hot extraction analyzes such as nitrogen, carbon and total bases. In total, the sampled soils were subjected to two types of analyses: classic analyzes carried out on the samples and total analyses.

For total analyzes (metallic trace elements), part of the fraction having passed the mesh is crushed to 0.2mm. The fine fraction thus obtained is incinerated in a muffle furnace at 450 °C for at least four hours in order to destroy the organic matter.

Microsoft Excel software was used for data entry and processing. Statistical Analysis System version 9.2 (SAS v. 9.2) software was then used for statistical analyses. These analyzes essentially consisted of analyzes of variance (one and two factors). The chemical parameters as well as the particle size data underwent a one-way analysis of variance (Position of the topo sequence) while the data related to heavy metals underwent a two-way analysis of variance (Position of the topo sequence and sampling horizons). Soil samples). The mean values were then compared with each other using the

Student Newman-Keuls test at the 5% threshold (Dagnelie, 1998) [7].

4. Results
4.1 Soil characteristics
4.1.1 Physical characteristics of soils according to altitude
Table 1 presents the physical characteristics of the soils according to altitude. One-way analysis of variance and the Student Newman-Keuls test revealed a significant difference ($p<0.05$) between the levels with regard to the rate of clay, fine silt, fine sand and sand. rude. However, no significant difference was noted regarding the rate of coarse silt ($p>0.05$). The Student Newman-Keuls test revealed that the high altitude significantly recorded the highest rates of clay, fine silt and fine sand while the low altitude recorded the highest rate of coarse sand (Table 1).

Table 1: Physical characteristics of soils according to altitude

Level	Clays (%)	Fine silt (%)	Coarse silt (%)	Fine sand (%)	Coarse sands (%)
Down_Alt	0.84±0.47b	0.56±0a	0.90±0.90a	3.88±0.36c	94.63±0.20a
Avg_Alt	33.97±17.89a	10.56±6.18b	3.38±2.07a	8.89±1.75b	43.22±23.88b
Top_Alt	28.58±17.44a	12.12±01.55a	4.39±4.03a	12.21±5.77a	42.70±37.25b
F-Value	0.71	0.58	2.45	1.71	1.04
Probability	0.031	0.042	0.63	0.03	0.02

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p> 0.05$) according to the Student Newman-Keuls test

4.1.2 Chemical characteristics of soils according to altitude
The chemical characteristics of the soils according to altitudes are presented in Table 2. The analysis of the table reveals that the analysis of variance revealed that the contents of carbon (C), organic matter (OM), calcium (Ca), magnesium (Mg), sodium (Na) and assimilable phosphorus (P ass) vary very significantly ($p<0.05$ to $p<0.001$) depending on the altitude. The Student Newman-Keuls test revealed that medium and high altitudes recorded the highest levels of carbon (C), organic matter (OM), calcium (Ca), and magnesium (Mg) while only the Mid-altitude recorded the highest level ($p<0.05$) of sodium (Na). On the other hand, the highest rate ($p<0.05$) of assimilable phosphorus was recorded at low altitude. However, no significant difference ($p>0.05$) was noted with regard to pH, nitrogen (N) and potassium (K).

Table 2: Chemical characteristics of soils according to altitude

Level	pH water	pH KCl	VS (%)	NOT (%)	C/N	MO (%)	That (.meq/100g)	Mg (.meq/100g)	K (.meq/100g)	N / A (.meq/100g)	Pass (mg/kg)
Down_Alt	6.84± 0.24a	6.92± 0.45a	0.63±0.05 b	0.02±0a	40.19±4.32 a	1.08± 0.09c	3.70± 0.58 b	0.46±0.02b	0.83±0.62a	0.36±0.06b	81.07±33.83 a
Avg_Alt	5.67± 0.49a	5.02± 0.74a	4.56± 1.95a	0.10±0.04 a	43.27±4.63 a	7.85±3.36 a	6.95± 1.91a	4.23±1.94a	0.81±0.31a	2.04±0.92a	44.97±24.25 b
High_Alt	5.27± 0.08a	4.18± 0.06a	3.65±3.18a	0.07±0.06 a	48.35± 7.76a	6.30± 5.49a	6.51± 0.16a	3.47±3.38a	0.35±0.17a	0.50±0.17b	9.15±2.06b
F-Value	2.26	2.87	0.79	0.87	0.41	0.79	0.31	0.71	0.42	1.27	1.38
Prob	0.38	0.13	0.01	0.23	0.07	0.01	0.03	0.04	0.56	0.002	0.001

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p> 0.05$) according to the Student Newman-Keuls test

4.1.3 Cation exchange capacity and saturation rate
The results of analysis of the saturation parameters (Table 3) of the different types of soil revealed that the sum of cations, the cation exchange capacity (CEC) and the saturation rate (V) vary significantly depending on the altitudes. The results of the Student Newman-Keuls test reveal that medium and high altitudes significantly ($p<0.05$) recorded the highest rates in sum of cations and cation exchange capacity (CEC) while the rate of saturation (V) is higher at lower altitudes (Table 3).

Table 3: Sums of cations, cation exchange capacity and saturation rate depending on altitude

Level	Sum of cations (meq/100g)	Cation Exchange Capacity (CEC)	Saturation rate (V) (%)
Down_Alt	5.35±1.17b	5.50±1.50b	101.51±8.49a
Avg _Alt	14.03±4.74a	20.69±9.51a	78.95±12.59b
Top_Alt	10.82±9.52a	15.96±13.96a	66.46±1.48b
F-Value	0.55	0.52	1.56
Probability	0.03	0.02	0.01

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p>0.05$) according to the Student Newman-Keuls test

4.1.4 Composition of heavy metals recorded at soil level
The heavy metal contents recorded in the soils under market gardening are recorded in Table 4. Analysis of the table reveals that at high altitude, the intermediate horizon recorded the highest ($p<0.05$) heavy metal contents. cadmium (Cd) compared to others. However, no significant difference ($p>0.05$) is observed between the horizons with regard to other heavy metals whatever the level of the watershed (Table 4). Generally speaking, high altitude soils recorded higher levels ($p<0.05$) for all heavy metals compared to low altitude which recorded the lowest values according to the Student Newman test. -Keuls (Table 4).

Table 4: Heavy metal content according to levels

Level	Horizon	Pb (mg/Kg)	Cd (mg/Kg)	Zn (mg/Kg)	Cr (mg/Kg)	Mn (mg/Kg)	Cu (mg/Kg)	Neither total (mg/Kg)
High_Alt	H1	20.54±19.94a	3.30±0 b	49.50±42.91a	48.48±42.73a	1822.22±1774.34a	12.88±12.03a	29.88±27.33 a
	H2	41.53±0 a	3.90±0a	42.54±38.17a	53.28±48.93 a	2855.73±2827.34 a	13.11±12.62a	35.33±32.86a
	H3	41.45±0 a	2;43±0c	42.41±39.13 a	49.54±46.22a	1027.93±1000.96 a	11.55±11.34a	30.57±29.06a
	Avg	34.51±6.78 A	3.04±0.19 A	44.73±18 A	50.43±20.60 A	1901.96±960 A	12.51±5.37 A	31.92±13.37 A
Down_Alt	H1	10.03±4.49a	0.84±0.20a	19.15±4.84a	21.27±7.67a	925.11±828.74 a	2.37±0.73a	5.78±1.41a
	H2	7.64±5.04a	0.72±0.16a	12.80±3.28a	22.29±3.42a	417.06±354.32 a	1.80±0.59a	7.82±1.04a
	H3	8.94±5.31a	0.77±0.12a	12.77±3.75a	21.92±6.01 a	758.79±694.49 a	1.73±0.65a	6.02±1.95a
	Avg	8.86±2.26B	0.77±0.07C	14.91±2.24 C	21.83±2.67B	699.98±308.70 B	1.97±0.32B	6.54±0.79B
Avg_Alt	H1	23.00±9.28 a	1.70±0.51 a	57.38±21.77 a	51.95±24.89a	433.14±223.77 a	12.20±5.64a	28.24±13.73a
	H2	22.38±9.49a	1.73±0.49a	41.39±19.87 a	45.65±23.48a	467.77±255.05 a	10.33±5.22a	27.95±13.90a
	H3	23.01±8.99a	1.69±0.55a	39.60±18.31 a	51.35±22.29a	776.58±451.01 a	9.31±4.57a	29.55±11.50a
	Avg	22.79±4.83 AB	1.70±0.27 B	46.12±10.74 B	49.64±12.34 A	559.16±176.42 B	10.61±2.72 A	28.58±6.84 A

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p>0.05$) according to the Student Newman-Keuls test

5.1 Water characteristics

5.1.1 Variation in major element contents depending on soil level: The contents of major elements recorded in the soils and at each altitude are recorded in table 5. Analysis of the table reveals that the medium altitude recorded the highest ($p<0.05$) ammonium (NH4+) contents compared to the other levels while the low altitude recorded the highest levels ($p<0.05$) of nitrates (N03-). However, no significant difference ($p>0.05$) is observed between the different altitude levels with regard to nitrite content (NO2-).

Table 5: Variation in major element contents according to altitude

Level	Ammonium (NH4+) (mg/L)	Nitrates (NO3-) (mg/L)	Nitrites (NO2-) (mg/L)
Down_Alt	0.01±0c	65.78±0.22a	0.14±0.06
Avg_Alt	0.16±0.09a	17.83±10.10b	0.15±0.10
High_Alt	0.06±0.05b	1.11±0.23c	0.04±0.01
F-value	0.8	9.54	0.34
Prob	0.04	0.02	0.73

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p>0.05$) according to the Student Newman-Keuls test

5.1.2 Phosphorus contents and exchangeable bases according to altitude

In general, the highest values ($p<0.05$) of orthophosphates (PO43-), potassium (K+), sodium (Na+), calcium (Ca2+) and magnesium (Mg2+) were recorded at the low and medium altitude (Table 6).

Table 6: Variation in phosphorus contents and exchangeable bases according to altitude

Level	Orthophosphates (PO43-) (mg/L)	Potassium (K+) (mg/L)	Sodium (Na+) (mg/L)	Calcium (Ca2+) (mg/L)	Magnesium (Mg2+) (mg/L)
Low_Alt	0.39±0.04a	378.43±80.33a	113.62±27.49a	22.84±1.20a	13.86±0.73a
Avg_Alt	0.40±0.21a	158.15±46.13b	187.98±73.16a	18.24±6.30a	11.06±3.82a
High_Alt	0.05±0.03b	18.89±11.47c	22.46±11.46b	2.40±1.60b	1.46±0.98b
F-value	0.89	8.56	1.40	2.48	2.49
Prob	0.04	0.02	0.02	0.02	0.01

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p>0.05$) according to the Student Newman-Keuls test

5.1.3 Variation in total salt and bicarbonate contents depending on altitude

The contents of total salts and bicarbonates according to altitude are recorded in table 7. Analysis of the table reveals that in general, the highest values ($p<0.05$) in chlorides (Cl-), sulfates (SO42 -) and Bicarbonates (HCO3-) were recorded at low and medium altitude (Table 7). However, the highest values of total iron content were recorded ($p<0.05$) in the high and medium altitude. No significant difference ($p>0.05$) is observed between the different altitude levels with regard to the fluoride content (F-).

Table 7: Variation in contentsin total salts and bicarbonatesaccording to the topo sequence

Slope level	Chlorides (Cl-) (mg/L)	Fluorides (F-) (mg/L)	Sulfates (SO42-) (mg/L)	Bicarbonates (HCO3-) (mg/L)	Total Iron (Fe2+/3+) (mg/L)
Down	479.25±124.25a	0.44±0.21	32.0±18.0ab	326.35±21.35a	0.01±0b
Medium	617.70±291.72a	0.39±0.09	55.75±7.31a	303.48±134.25a	0.18±0.12a
High	44.38±30.17b	0.37±0.12	2.0±0c	39.65±15.25b	0.12±0.10a
F-value	1.05	0.07	7.56	1.28	0.48
Prob	0.02	0.94	0.03	0.03	0.04

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p>0.05$) according to the Student Newman-Keuls test

5.1.4 Variation of ttemperature and physical parameters of the wateraccording to the topo sequence: The temperature and physical parameters of the waters according to the altitudes are recorded in table 8. Analysis of the table reveals that the low and medium altitudes recorded the highest ($p<0.05$) values of total hardness, conductivity and TDS compared to other levels while high and medium altitude recorded the highest values ($p<0.05$) of turbidity. However, no significant difference ($p>0.05$) is observed between the different altitudes with regard to water temperature (Table 8).

Table 8: Variation of ttemperature and physical parameters of the water according to the topo sequence

Slope level	Temperature (°C)	Total Hardness (mg/L)	Color (UCV)	Conductivity (µS/cm)	TDS (mg/L)	Turbidity (NTU)
Low_Alt	27.63±0.04	114.0±6.0a	11.50±2.50c	1258.0±213.0a	628.50±106.50a	0.36±0.12b
Avg_Alt	28.13±0.24	91.0±31.43b	152.0±106.10a	1813.25±771.25a	906.50±385.72a	18.68±16.78a
High_Alt	28.21±0.30	12.0±8.0c	93.0±80.0b	139.0±76.0b	70.0±38.0b	17.79±16.21a
F-value	1.21	2.48	0.45	1.29	1.29	0.31
Prob	0.37	0.01	0.04	0.03	0.03	0.04

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p> 0.05$) according to the Student Newman-Keuls test

5.1.5 Variation of acidity, salinity and oxygen content according to the topo sequence

In general, waters from mid-altitude and low altitude are more basic and saline ($p<0.05$) while those from high altitude are more acidic. However, no significant difference ($p> 0.05$) is noted between the different altitudes with regard to the dissolved oxygen content (Table 9).

Table 9: Variation of acidity, salinity and oxygen content according to the topo sequence

Slope level	pH	Salinity (mg/L)	Dissolved oxygen (mg/L)
Down_Alt	7.50±0.12a	0.62±0.11b	5.79±0.32
Avg_Alt	7.22±0.24a	0.93±0.40a	4.81±0.53
High_Alt	5.47±0.11b	0.07±0.04c	4.29±0.18
F-value	17.90	1.28	1.61
Prob	0.005	0.03	0.28

Means followed by the same alphabetic letter of the same character and for the same factor are not significantly different ($p> 0.05$) according to the Student Newman-Keuls test.

5. Discussion

The analysis of variance revealed that the contents of carbon (C), organic matter (OM), calcium (Ca), magnesium (Mg), sodium (Na) and assimilable phosphorus (P ass) vary very significantly ($p<0.05$ to $p<0.001$) depending on the altitudes. The Student Newman-Keuls test revealed that medium and high altitudes recorded the highest levels of carbon (C), organic matter (OM), calcium (Ca), and magnesium (Mg) while only the Mid-altitude recorded the highest level ($p<0.05$) of sodium (Na). On the other hand, the highest rate ($p<0.05$) of assimilable phosphorus was recorded at low altitude. However, no significant difference ($p>0.05$) was noted with regard to pH, nitrogen (N) and potassium (K).

Analysis of the table reveals that at high altitude, the intermediate horizon recorded the highest ($p<0.05$) cadmium (Cd) contents compared to the others. However, no significant difference ($p>0.05$) is observed between the horizons with regard to other heavy metals whatever the level of the watershed (Table 4). Generally speaking, high altitude soils recorded the highest levels ($p<0.05$ for all heavy metals compared to low altitude which recorded the lowest values according to the Student Newman test). Keuls

The middle altitude recorded the highest ($p<0.05$) ammonium (NH_4^+) contents compared to the other levels while the low altitude recorded the highest ($p<0.05$) nitrate (N03-) contents. However, no significant difference ($p>0.05$) is observed between the different altitude levels with regard to nitrite content (NO2-) the highest values ($p<0.05$) in chlorides (Cl-), sulfates (SO42) and bicarbonates (HCO3-) were recorded at low and medium altitude (Table 7). However, the highest values of total iron content were recorded ($p<0.05$) in the high and medium altitude. No significant difference ($p>0.05$) is observed between the different altitude levels with regard to the fluoride content (F-).

The low and medium altitudes recorded the highest ($p<0.05$) values of total hardness, conductivity and TDS compared to the other levels while the high and medium altitudes recorded the highest values ($p<0.05$) of turbidity. However, no significant difference ($p>0.05$) is observed between the different altitudes with regard to water temperature. These results are similar to those of CCA Ahouangninou (2013, p. 88) and (Aubertot *et al*., 2005) [3] insofar as they showed that phytosanitary treatments through spraying foliage contribute to air pollution, soils, surface and groundwater. These results are also similar to

6. Conclusion

Market gardening activity in the southwest of Benin in general and in particular in the communes of Grand Popo and Comé allows actors to get by but this harms the environment. The use of chemicals such as fertilizers, urea, NPK, insecticides with the aim of increasing yields, contributes to the pollution of the soil, the water table through runoff, towards the courtyards and bodies of water. Market gardening and fish products are contaminated, the air is polluted following the spreading of herbicides. The consumption of these food products, of the water which is exposed to these chemicals, contributes to the deterioration of human health.

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