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Collection, Disposal and Characterization of Faecal Sludge from the City of Niamey (Niger)

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Abstract

The management of faecal sludge (FS) is a major problem in many towns in Niger, and in Niamey (the capital) in particular. Households and public places are mainly equipped with autonomous sanitation facilities (traditional latrines, Sanplat latrines, VIPs, etc.). This can lead to a proliferation of dumping sites, an increase in disease and pollution of surface and groundwater [1, 2].

The aim of this work is to describe the BV collection and evacuation system, and to identify shortcomings for better management. To this end, field work and laboratory analyses were carried out.

Analyses reveal a high concentration of Nitrate (236.4 mg. L^{-1}) and Phosphorus (28.18 mg.L^{-1}), the average values recorded for BOD_5 and COD are 1144.4 mg O $_2$.L^{-1} and 700 mg O_2 .L^{-1} respectively, and fecal streptococci and coliforms were recorded at 3.33.106 and 1.81.106 CFU/100mL and 2278.8 eggs/L respectively.

At, given the composition of this sludge, it is necessary to undertake awareness-raising campaigns aimed at stakeholders in the management of wastewater treatment plants, and to popularize the technical resources of the faecal sludge management sector.

Keywords: Faecal sludge, Niamey, water, pollution, BOD and COD

1. Introduction

In most developing countries, excreta are collected in individual household sanitation systems [3]**.** These systems, whether in households or public kiosks, generate sludge which must be collected, disposed of and treated regularly, as it can create a nuisance in the surrounding environment and damage public health **[4]**. According to the World Health Organization [5] 2.6 billion people worldwide lack access to adequate sanitation, and nearly 1.1 billion continue to defecate in the open. Faecal sludge is discharged into the environment in an uncontrolled manner, due to a lack of adequate disposal systems and poor management of faecal matter. This contact of faecal matter with the environment presents risks of food contamination through flies and other vectors, groundwater pollution through infiltration and surface water pollution through discharge into the river, which is the town's main source of drinking water and whose waters are used for market gardening and rice growing. The open defecation practised by part of the population endangers the whole community, given the increased risk of contracting diarrhoeal diseases, cholera, vermin infestations, hepatitis and other associated illnesses [5]**.**

Yet these problems could be avoided with a proper management system that takes into account sources of production, emptying methods, transport and safe disposal or reuse of these sludges [4].

In view of the negative impact on the environment, the health risks to which people are exposed, and the possibilities for recycling this material, an improvement in the system for managing faecal sludge is essential.

The aim of this work is to evaluate the current management techniques for faecal sludge in the city of Niamey (Niger), to determine the physico-chemical and bacteriological characteristics of this sludge and their impact on the population and on landfill sites, to deduce the main constraints and to propose solutions for improvement.

2. Materials and methods

2.1 Presentation of the study area

Located in West Africa, Niger is a Sahelian country covering an area of 1,267,000 km^2 . It is bordered to the north by Algeria and Libya, to the south by Nigeria and Benin, to the west by Mali and Burkina Faso, and to the east by Chad. Niger is a continental country whose only permanent watercourse is the River Niger, which crosses the country for 550 km. Rainfall is irregular, and the area that receives the most rain (but is the least extensive), which lies towards the border with Benin, receives only 600 to 800 mm of rain per year [5].

Niamey, the capital of Niger, which is our study area, is located in western Niger between latitudes 13°20' and 13°35' North and longitudes 2°00' and 2°24' East. It is built on the banks of the Niger River, which flows through the city for some 15 km, forming the structuring element of its landscape. The city of Niamey was established as an Urban Community by decree N°88-393/PCMC/MI of November 24, 1988. In 2002, it was subdivided by the decentralization law into five (5) communal districts [6].

Groundwater is contained in altered or fissured formations of the Precambrian basement. They are located in sedimentary rocks and bedrock. Water tables in sedimentary rocks are shallow, located on average some twenty meters above river level, making them particularly vulnerable to pollution. Deep water tables in semi-permeable basement formations have an average depth of 65 m and an average flow rate of 4.6 m /hour.

There are 3 types of soil in the Niamey region:

- the indurated soils of the lateritic cuirassed plateaus, which are poorly developed, highly degraded and offer no agricultural possibilities due to their shallowness, impermeability and, above all, extreme aridity.
- sandy soils, including tropical ferruginous soils in sandy valleys.
- the hydro-morphic soils of the river valley, which form part of a vast flood plain and are relatively fertile.

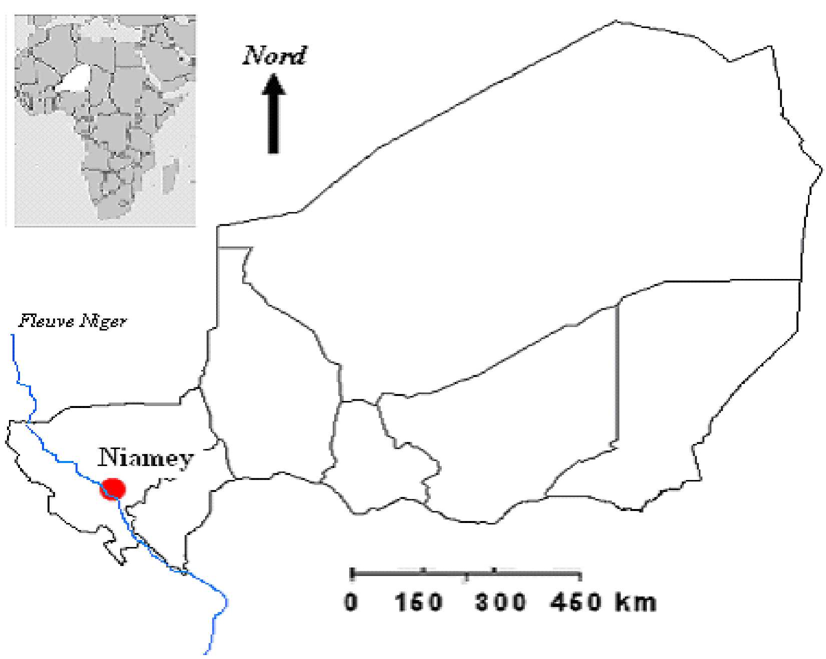

Figure 1: Location of Niger [7])

In this city, there are several types of habitat that define housing zones. Depending on the availability and distribution of drinking water, hygiene and sanitation (WASH) facilities, there are six (6) types of housing zones [8]**:**

- Zone 1: characterized by a high level of hygiene, good water supply, low population density and the presence of luxury housing. This category includes the residential neighborhoods of Plateau, Kwara-Kano, Poudrière, Cité-Caisse and Koubia;
- Zone 2: has the same characteristics as Zone 1, but the buildings are less luxurious, more dilapidated and run-down (Quartier Terminus, etc.);
- Zone 3: This zone is characterized by solid housing with several households sharing the same water and sanitation facilities (Route de Filingué, Yantala haut neighborhoods);
- Zone 4: This is the dominant zone in the city. In this zone, housing is collective and population concentration is higher than in zone 3, posing many more hygiene problems (Madina, Kalley Nord, Sabongari, Banizoumbou, Kalley Sud, Nouveau Marché, Gamkallé, Talladjé, Boukoki neighborhoods);
- Zone 5: characterized by settlements with a predominance of traditional latrines (Marouey, Zongo, Gandatié, Aviation, Karadjé, Pont Kennedy, Gaweye Nogaré, Lamordé and Kirkissoye neighborhoods).

2.2. Survey work

Questionnaires were drawn up for households, emptiers and neighbourhood chiefs, and interview guides were prepared for those in charge of hygiene and sanitation in the town halls. The term "household" here refers to all the families in a concession who share the same facilities for storing and disposing of liquid waste, i.e. domestic wastewater and excreta [9]:

The method used is that of two-stage reasoned choice using stratified sampling [10].

The variables studied during the survey include :

1. The type of non-collective sanitation facilities used ;
2. Frequency of emptying ;
3. The type of drain used ;
4. What happens to sludge after emptying ;
5. Place of discharge ;
6. Number of persons in household ;
7. The inconvenience caused by spilled sludge ;
8. The number of vacuum cleaners in the neighborhood ;

According to the latest report from the Institut National de la Statistique [11], the city of Niamey has around 1,026,848 inhabitants spread across 58 neighborhoods. It is also distributed across the four (4) types of urban fabric (high standard, medium standard, low standard, single) at an average of seven (7) people per household. This gives a total of 146,293 households in the city.

The number of households to be surveyed per commune (Table 1) was determined according to the number of neighbourhoods in the commune and the types of fabric found in the commune. A total of 3817 households were surveyed in the city of Niamey.

Table 1: Sample distribution by neighborhood and number of households

Municipality	Population	Number of households	Number of neighborhoods	Number of households surveyed
Commune I	210 020	30 003	12	625
Commune II	246 898	35272	17	519
Commune III	163 175	23311	16	364
Commune IV	274 484	39212	6	1634
Commune V	132 271	18896	7	675
Total	**1 026 848**	**146.293**	**58**	**3817**

2.3. Sample collection and analysis

Sewage sludge sampling

Noisy faecal sludge was collected directly from the disposal sites identified during surveys in the city of Niamey (Figure 2). Four one-liter sub-samples were taken from different locations at each disposal site. These samples were combined to form a single one-liter sample (composite samples) [4]. These were then collected in vials and bottles (previously washed with distilled water), sealed and labelled. They are then placed in a cooler at 4°C for storage, and transported to the laboratory.

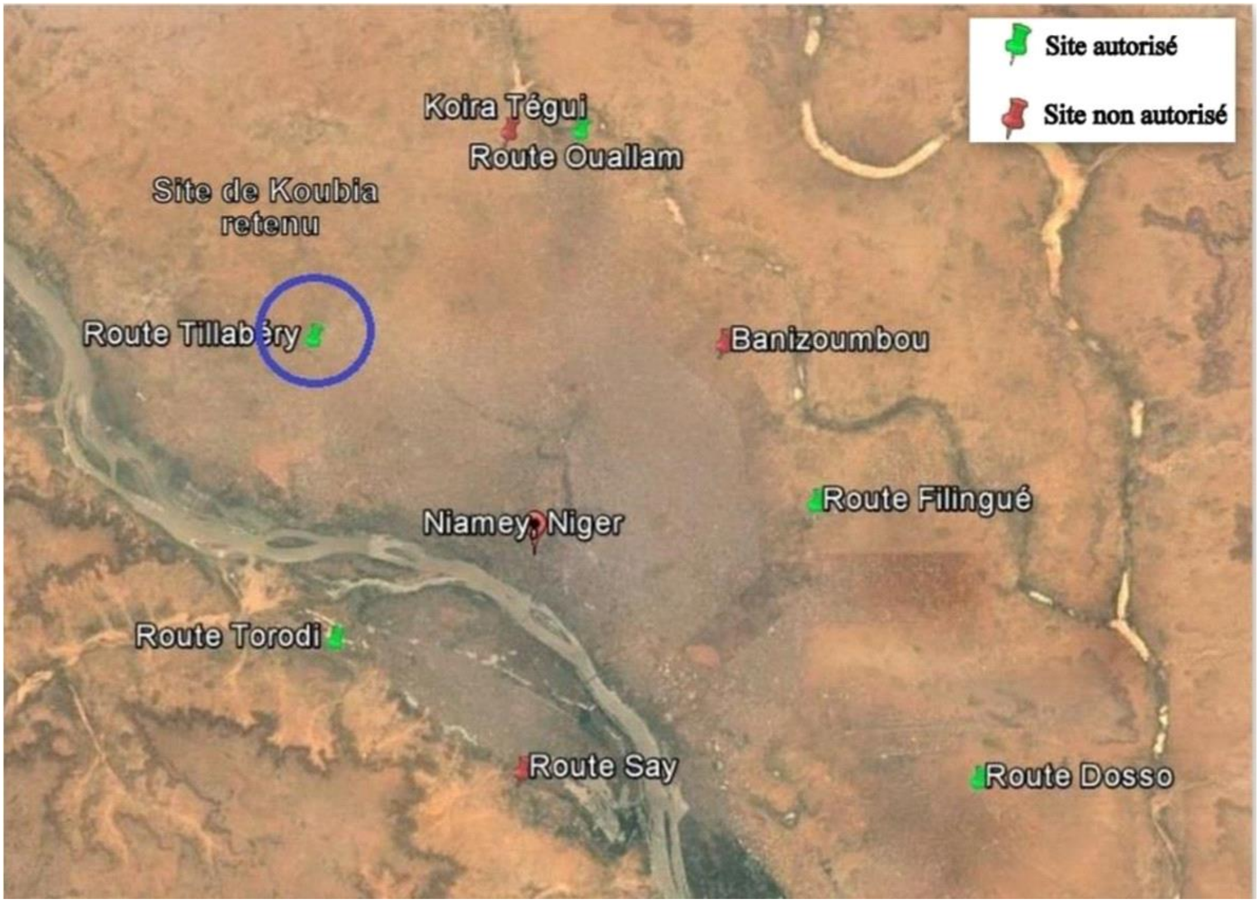

Figure 2: Location of unloading sites in the city of Niamey (make a map)

2.4. Methodology

Sample analysis

To determine the composition of Niamey's sewage sludge, physico-chemical, bacteriological and parasitological parameters were determined. Parameters assessed included: temperature, conductivity, pH, Electrical Conductivity (EC), redox potential (Eh), Dry Matter (DM), Dry Volatile Matter (DVM), ammoniacal nitrogen (NH_4^+), nitrate ions (NO_3^-), nitrite ions (NO_2^-), phosphates (PO_4^{3-}), Chemical Oxygen Demand (COD), and BOD_5 . Parasites such as helminth eggs were also determined.

The parameters selected enable us to better understand the impact of these sludges on the health of surrounding populations (proliferation of water-borne diseases), on groundwater pollution and the dangers of eutrophication in waterways.

In-situ measurement

Temperature (T), Hydrogen Potential (pH), Electrical Conductivity (EC) and Redox Potential (Eh) are the parameters measured in the field at each sampling point. These parameters were measured with the HI 9828 pH/ORP/EC/DO Multiparameter, equipped with several probes. Readings are taken after stabilization of the display on the instrument's screen. The method complies with AFNOR standard 90 008.

Methods for determining parameters analyzed in the laboratory

Dry matter (DM) and dry volatile matter (DVM) are determined in accordance with NF T 90-029. A 50mL sample is evaporated in a water bath, then the residue is dehydrated in an oven at 150°C for 24 hours. The dehydrated sample is then acclimatized to laboratory conditions in a desiccator, and weighed to determine the M.S. content (dry matter in mg. L^{-1}) according to the formula:

$$MS\ (mg.L^{-1}) = \frac{(P_2 - P_1) * 1\,000\,000}{V} \qquad Eq1$$

P_2 : Vacuum porcelain mass in g
P_1: Mass of porcelain after oven drying at 105°C for 24h in g
V: Sample volume in mL
Dry volatile matter (DVM) is obtained from DM using the formula:

$$MVS = \frac{(P_2 - P_3) * 1\,00\,000}{V} \qquad Eq2$$

P_2 : Mass of porcelain after 24h in oven in g
P_3 : Mass of porcelain after baking at 505°C for 3 hours
V: Sample volume in mL
Chemical Oxygen Demand (COD) is determined by oxidation with an excess of potassium dichromate in an acid medium at 150 °C, in the presence of silver sulfate as a catalyst and mercury sulfate to avoid interference from chloride ions, in accordance with AFNOR standards. The value is read by JICA DR/890 spectrophotometry at the appropriate wavelength for the COD range selected.
The five-day Biochemical Oxygen Demand (BOD_5) was determined by the five-day incubation method in the dark at a temperature of 20°C using a "*LovibondOxiDirect"* device, measured by resistive electronic pressure probes.
Ammoniacal nitrogen (NH_4^+), nitrates (NO_3^-), nitrites (NO_2^-) and ortho-phosphates (PO_4^{3-}) were determined colorimetrically using a HACH DR/3900 spectrophotometer.
Parasites are generally found in faecal discharges, but the type and concentration of parasites vary according to the level of infection observed in a given population. Analysis of parasitological parameters is based on helminth egg counts, as these are the most representative and easiest to detect of resistant parasites.
Helminth eggs are determined by the two-phase method in accordance with XP X33-017, July 2004. Diphasic methods involve bringing together two immiscible liquid phases, one aqueous (with a density lower than that of the parasitic elements) and the other consisting of a lipophilic solvent (usually ether). The sample is triturated in the aqueous solution, then emulsified with the lipophilic reagent. After centrifugation, only the pellet is analyzed macroscopically.

3. Results

The survey was conducted in two (2) companions. The first campaign ran from July 10 to October 20, 2018 and the second from March 15 to June 18, 2019.

Within households

Several types of self-contained sanitation facilities were encountered during the surveys: traditional latrines, Sanplat latrines (which are slightly improved traditional latrines), *VIP* latrines and Modern latrines (which include manual flush toilets with a single or double pit).
Figure 3 shows the distribution of on-site sanitation facilities in the city of Niamey.

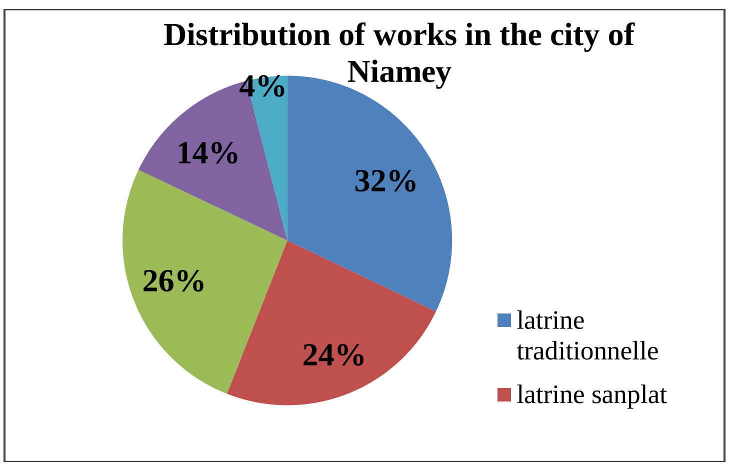

Figure 3: Breakdown of wastewater facility types

The results of surveys carried out in the city of Niamey show a 96% rate of access to on-site sanitation facilities, with traditional latrines predominating (32%). Modern latrines are present in 26% of households surveyed, Sanplat latrines in 24%, VIP latrines in 14%, and 4% (i.e. 153 households) have no access to a sanitation facility.
It was also identified that some households have two types of structure in their homes: a Sanplat latrine in the courtyard and a Modern latrine in their main bedroom.

3.1. Close to drainers
Two types of emptying were identified during our survey in our study area:

Mechanical draining

This type of emptying is carried out by a number of operators, most of them privately-owned, who are located in different parts of the city. According to the results of our surveys, most of the service providers are not structured as companies (privately-owned vehicles), and contact with the emptiers is made either by telephone call, by going to the emptier's truck parking area, or by informing a canvasser in order to benefit from the service. The emptiers operate throughout Niamey, regardless of neighborhood.

Manual emptying

It consists of extracting the contents of the pits and burying them in a hole dug inside the house or in front of it. They use buckets, shovels, pickaxes, ropes, crowbars, carts and, occasionally, grit or kerosene to combat odors. The contents can also be transported by motorized cart or drum to other locations, such as gutters. It is important to note that it proved very difficult to interview manual emptiers because of their informal nature. Nevertheless, some of them were very cooperative and made our work easier. The following images illustrate the manual emptying activity.

Figure 4: Manual draining

According to the survey results, the distribution of emptying methods in the city of Niamey is shown in the figure below.

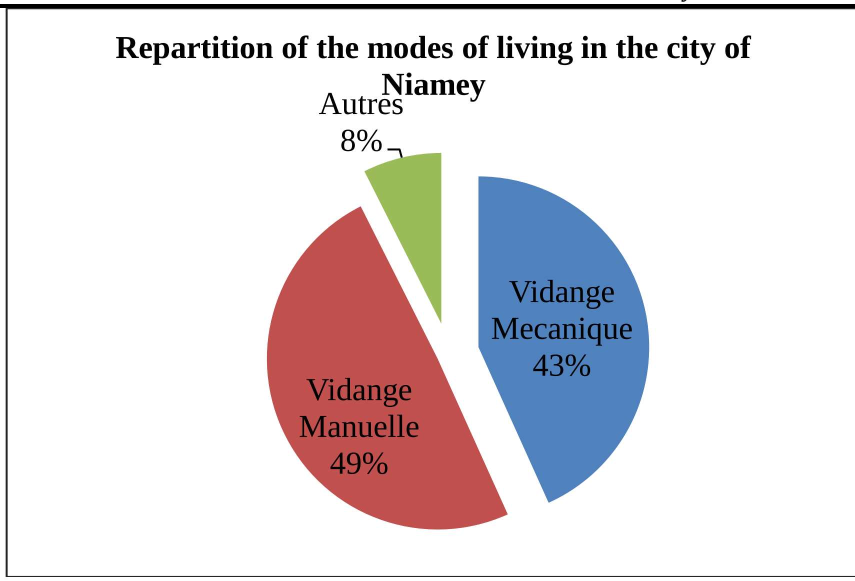

Figure 5: Distribution of emptying methods in the city of Niamey

Analysis of figure 5 shows that manual emptying is used by 49% of households surveyed, compared with 43% using mechanical emptying, while the remaining 8% sometimes use both types of emptying. This choice is justified by the fact that mechanical emptying does not empty the entire pit. This disparity can be explained by a number of factors, including the lack of suitable roads in certain neighborhoods, the price of emptying, the quality of the ANC structures and their positioning in the home, the income of the head of household, etc.

Figures 6 and 7 show, respectively, the frequency with which structures are emptied and the frequency with which structures are emptied by emptying mode.

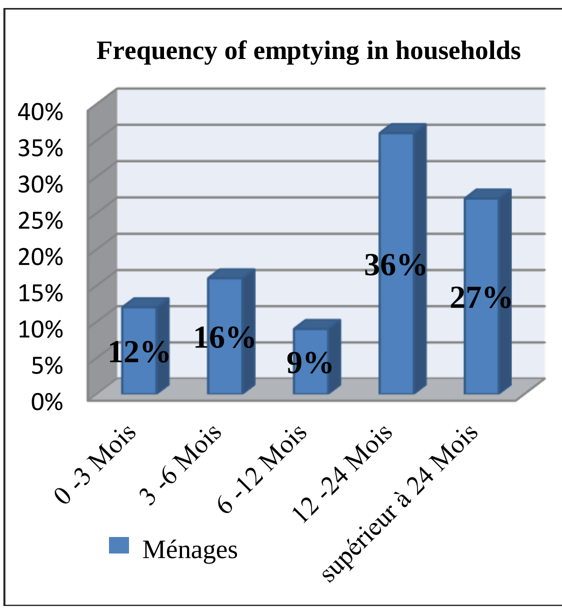

Figure 6: Frequency of emptying in households

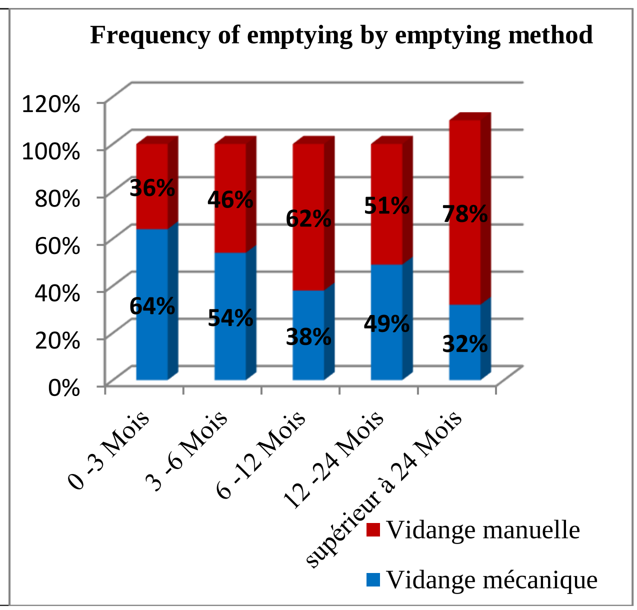

Figure 7: Frequency of emptying by emptying method

Analysis of figure 6 shows that 73% of households surveyed empty their pits before two (2) years, and 9% of households empty their pits between six (6) and twelve (12) months. This frequency could be explained by a number of factors, including the depth of the pits, the number of people using the latrines and so on. Figure 7 shows the frequency of emptying by emptying method. Households with an emptying frequency of less than six (6) months generally use mechanical emptying more than manual emptying. For frequencies of more than twelve (12) months, manual emptying is much more popular, as it allows almost all the sludge in the pit to be emptied. These emptying frequencies show us that the sludge arriving at the plant or at the dumping site is generally fresh, highly unstable sludge.

3.2. Oil change prices by mode

Analysis of the figures below shows that the price charged ranges from 10,000 to over 40,000FCFA for mechanical emptying, and from 5,000 to 25,000FCFA for manual emptying.

In fact, 18% of households surveyed carry out mechanical emptying at a cost of less than or equal to 20,000FCFA, compared with 82% at prices ranging from 20,000 to over 40,000FCFA, with 6% over 40,000FCFA (Figure 8).

As for manual emptying, 67% of households surveyed pay an amount less than or equal to 15,000FCFA and 33% pay an amount less than or equal to 25,000FCFA.

However, it is important to know that the price of oil changes depends on several important factors:

- ✓ Relationship;
- ✓ The distance between the emptying site and the nearest dumping site;
- ✓ Fluctuating fuel prices
- ✓ Dealership accessibility, etc.

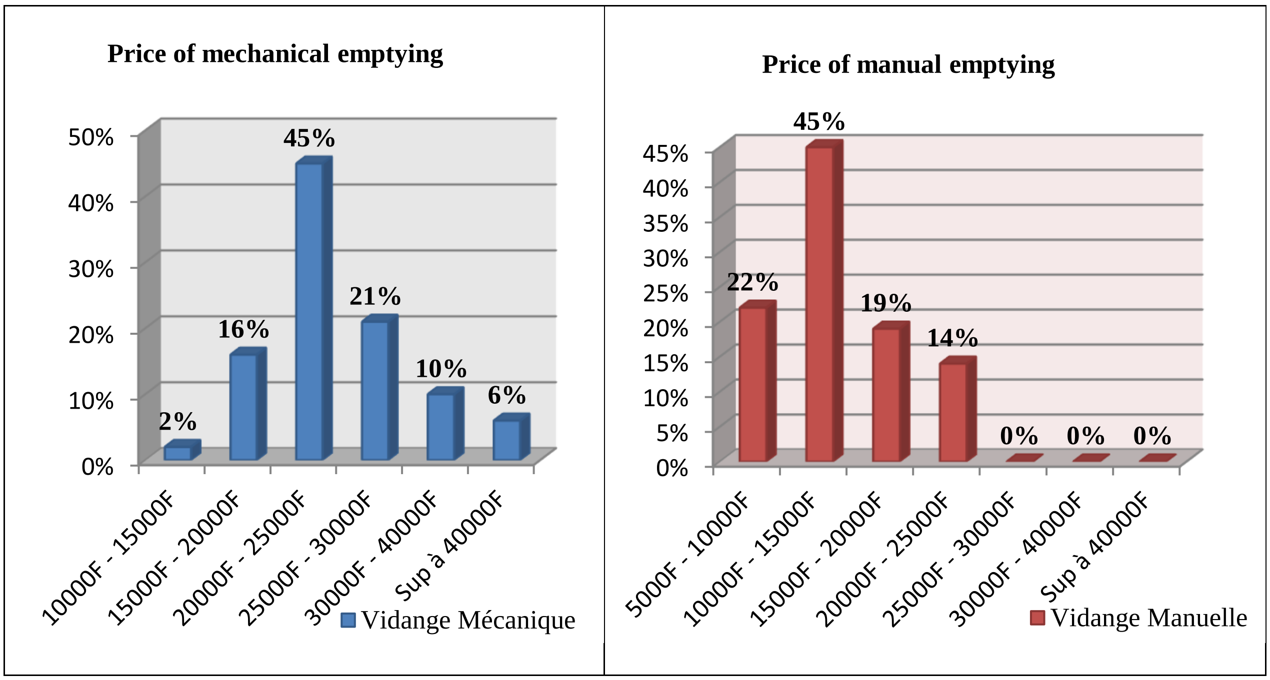

Figure 8: Minimum and maximum prices for mechanical and manual emptying

The results of physico-chemical parameter analysis are given in Table 3.

Table 3: Physico-chemical characteristics of the raw sewage sludge deposited.

	Carrière route torodi	Quarry road kouaratagui	Quarry road North beam	Quarry road banizoumbou	Carriѐe koubia	Quarry road Airport	INFORMAL SITE 1	INFORMAL SITE 2	INFORMAL SITE 3	AVERAGE	STANDARD
T (°C)	30,1	33,1	34,2	35,1	31,5	34,2	32,8	33,8	36,2	33,40	18-40
PH	8,04	7,99	9,1	8,91	8,38	9,01	7,84	7,94	8,81	8,44	6,5-9,0
C (µS. cm^{-1})	4950	9950	1354	2413	1532	2121	1134	2415	1289	3017,5	1000
eh (mV)	-81,7	-34,8	-17,5	-1,4	41,6	-39,3	-44,3	-5,7	-68,1	-27,90	ND

The average values for pH, temperature, ammonium ions and nitrites obtained from the sewage sludge analyzed are in line with standards for the discharge of liquid sludge into the environment. However, average values for electrical

sal (mg. L^{-1})	3,16	0,76	0,66	0,36	0,71	0,51	0,52	0,54	0,79	0,89	ND
TDS $(mg.L)^{-1}$	2917	757	667	375	713	521	527	565	792	870,40	ND
MS $(mg.L)^{-1}$	3044	3246	42136	1654	7954	1228	656	1500	908	6925,1	ND
MVS $(mg.L)^{-1}$	1014	2150	21088	936	5744	612	394	868	856	3740,2	ND
NH_4^+ $(mg.L)^{-1}$	101,0	18,1	13,0	57,2	6,5	23,5	34,4	62,0	82,0	44,19	60,0
NO_2mg.L$)^{-1}$	0,14	0,72	1,17	0,14	2,30	0,019	0,02	0,15	0,24	0,55	0,9
NO_3^- $(mg.L)^{-1}$	158,0	340,0	514,0	107	520,0	42,0	43,0	143,0	261,0	236,40	11,4
IN. $_4$mg.L$)^{-1}$	26,0	11,5	35,0	18,1	16,0	6,5	16,2	21,3	103,0	28,18	5
DCO ($mgO_2.L^{-1}$)	860	740,0	2400	530	3550	450	700	630	440	1144,4	150
DBO $_5$(mgO $L)_2^{-1}$	200	650	1800	400	1650	150	500	600	350	700	50
DCO/DBO_5	4,3	1,14	1,33	1,32	2,15	3,0	1,40	1,05	1,25	1,88	ND

conductivity, ortho-phosphate ions and nitrite ions are well above standards. For carbonaceous pollution, the Chemical Oxygen Demand (COD) and five-day Biochemical Oxygen Demand (BOD_5) values ranged respectively between 440 and 3550m gO_2 . L^{-1} on the one hand, and 200 and 1800 mgO /L on the $_2$other. Although these values are low compared with those obtained by other authors in other countries [4, 12, 13]), they are well above the discharge standards set in Niger at 150 and 50mg/L respectively.

Bacteriological analysis results are shown in Table 4.

Table 4: BV bacteriological and parasitological characteristics

	Carrière route torodi	**Quarry road kouaratag**	**Quarry road North beam**	**Quarry road banizou mbou**	**Career koubia**	**Quarry road Airport**	**INFOR MAL SITE 1**	**INFOR MAL SITE 2**	**INFORM AL SITE 3**	**AVERAG E**	**STANDAR DS [14]**
C.F (UFC/100mL)	30.10^3	$1,4.10^6$	$3,5.10^5$	$1,5.10^6$	$1,8.10^6$	$1,2.10^6$	$1,6.10^5$	$5,7.10^6$	$4,6.10^6$	$1,81.10^6$	2.10^3
E-Colis (UFC/100mL)	28.10^3	$1,3.10^6$	2.10^5	$1,31.10^6$	$1,310^6$	$7,8.10^5$	$1,3310^5$	$4,9.10^6$	$4,4.10^6$	$1,60.10^6$	
S.F (UFC/100mL)	70.10^4	$2,1.10^6$	$10,4.10^6$	$1,8.10^6$	$7,7.10^5$	$9,5.10^5$	$9,8.10^4$	4.10^6	$14,1.10^6$	$3,88.10^6$	10^4
helminth EGGS (eggs/L)	3360	5320	360	378	7600	900	680	912	1000	2278,8	

Average CF and SF levels were found to be similar and lower than those reported by other authors. In fact, pathogen levels depend on factors such as the length of storage in the structure, the temperature of the medium and the dilution rate.

3.3. Discussions

Physico-chemical parameters

Temperature

Faecal sludge temperatures recorded in the city of Niamey ranged from 36.2 to 30.1°C, with an average of 33.4°C. These values comply with sludge discharge standards.

Being an important parameter, temperature favors microbial mineralization activity at discharge sites, or in the basins of a wastewater treatment plant [9]. It is also important for assessing the characteristics of a treatment plant, as its sudden variation has considerable effects on the purifying bacteria in the environment.

pH

The pH values measured at the unloading sites range from 7.84 to 9.1, with an average of 8.44. As Table 3 shows, the extreme pH values obtained were 9.01 at the Nord Faisceau quarry and 9.01 at the Route Aéroport quarry, values compatible with the development of the bacteria that purify the sludge.

The pH, temperature and salinity of sewage sludge can be limiting factors for the development of purifying bacteria. These bacteria generally thrive at pH levels between 5 and 9. This is why these different parameters can limit the growth of certain bacteria, thus impacting treatment efficiency [15].

Conductivity

Conductivity ranged from 1134 to 9950 µS. cm^{-1} with an average of 3017.5 µS.cm^{-1} as shown in Table 6. The highest values were recorded at the Route Kouaratagui quarry (9950 µS.cm^{-1}) and at the Route Torodi quarry (4950 µS.cm^{-1}). This indicates that the sludge deposited is highly mineralized, but still fermentable given the levels of biodegradable organic pollutants. These results confirm the presence of mineral salts in the medium. An excessive increase in conductivity in the aquatic environment can lead to changes in the bacterial ecosystem and also influence the survival of aquatic flora and fauna. According to studies carried out by Koné et al. in 2012, high salinity can lead to soil clogging, with a negative impact on the development of many agricultural speculations.

Chemical parameters

Volatile dry matter (VDM) and dry matter (DM)

The concentration of volatile dry matter (VDM) and dry matter in sewage sludge averaged 3740.2 and 6925.1 mg.L^{-1} respectively. Some authors have reported higher levels in similar studies. Indeed, Koné and Strauss (2003) report average SVD values of 12000mg.L^{-1} and 7080 mg.L^{-1} of DM. This confirms the wide variability in sludge characteristics, which depends on the source of the sludge. The low results obtained in this study could be explained by the discharge of grey water into septic tanks (dilution). The impact of rainwater is not negligible either (Strauss et al., 2004).

Ammonium, Nitrate, Nitrite

The ammonium values recorded at the disposal sites are below the standard, which is 60.0 mg.L^{-1} except at the Torodi road quarry, which is 101 mg.L^{-1} and at the 2^{em} informal site identified during our surveys, which is 62.0mg/L.

The average nitrate concentration is 236.40 mg.L^{-1}. These values exceed discharge standards, justifying the need for sludge management to avoid the risk of polluting surface and groundwater [16, 17]). These results can be explained by the quality of the structures (septic tanks or latrines) and the frequency of emptying. Indeed, septage with a long residence time in the tank generally has a higher mineralization rate [18]. Nitrites range from 0.019 to 1.17 mg.L^{-1} with an average of 0.55mg/L. These values are below the norm, which is set at 0.9mg/L, except at the Nord faisceau and Koubia quarries, where values of 1.17 and 2.30 mg.L^{-1} were recorded respectively. Being an oxidized form of nitrogen, nitrite ions are not stable and can evolve into nitrates in an aerobic environment during the sludge dewatering process.

Ortho-phosphates

Phosphorus, found in sludge in various forms (organic phosphorus, ortho-phosphates, etc.), can come from food, but also from natural or man-made sources. These nutrients can be put to good use in agriculture, but at high levels they can contribute to the eutrophication of surface waters, which poses a real danger to aquatic flora and fauna [19]. Values in excess of the norm were recorded at all of the city's landfill sites.

COD and BOD$_5$

The mean values for Chemical Oxygen Demand (COD) and Biological Oxygen Demand after five days (BOD$_5$) are 1144.4 and 700mgO/L$_2$ respectively. The COD/BOD ratio$_5$ is between 1 and 5 for all the samples studied, indicating that the sewage sludge is still ***biodegradable***. It remains fermentable, which means that it may need to be treated to meet discharge standards.

Microbiological and parasitological pollution

The results of the microbiological parameters reveal that the number of *E. coli* varies in the interval [28.10^3 - 4,9.10^6 UFC/100mL] and the average number is 1,60.10^6 UFC/100mL, the fecal coliforms have numbers varying in the interval [30.10^3 - 5.7.10^6 UFC/100mL] with 1.81.10^6 UFC/100mL as the average number, and finally fecal Streptococci whose numbers vary in the range [70.10^4 - 14.1.10^6 UFC/100mL] with an average of 3.33.10^6 UFC/100mL. The levels found in the present study are also lower than those reported by WHO (2006) in various regions, with levels sometimes exceeding 107 CFU/100 mL in CF. In all cases, bacteriological analyses are of interest given the risks of contamination of surface water and groundwater by pathogens [20].

4. Conclusion

The management of faecal sludge in the city of Niamey is fraught with difficulties. The various problems linked to this management are diverse and occur at several levels (households, urban community, ministerial delegations, non-governmental organizations, private companies, etc.).

According to the estimates made in this study, an average volume of 4599.39 m^3 /year of faecal sludge is produced. After emptying, this sludge is discharged untreated into the environment. It is dumped either in households, gutters, rivers or streets (manual emptying), or on the outskirts of the city in old quarries or fields (mechanical emptying).

This sludge is a source of many nuisances for the surrounding population (odors, mosquitoes, diseases, etc.) and for the environment.

Analyses of faecal sludge show that its pollutant load is very high compared with the discharge standards required by regulations.

Given the consistency and chemical, microbiological and parasitological characteristics of this sludge, it is important to consider the possibility of treating it to reduce its impact on health and the environment.

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