

Research Article

Perceptions of the Environmental and Health Impacts of Effluents from the Mofolé Slaughterhouse (Mokolo, Far North Cameroon)

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Abstract

This article presents the results of a survey on the environmental and health risks associated with the effluents from the Mokolo slaughterhouse, located in the urban area of Mofolé. The study was conducted using random sampling, which included 262 questionnaires administered to 65 households, as well as 20 interview guides with the slaughterhouse managers, butchers, and representatives from services such as the Divisional Delegation of Environment, Protection of Nature and Sustainable Development (DDEPDED), Divisional Delegation of Livestock, Fisheries and Animal Industries (DDEPIA), and the Municipality. The results indicate that 62% of the participants are women, reflecting the local demographics. It is also noted that 73% of the effluents lack any management system, and 99.6% of households report that the slaughterhouse's wastewater is discharged into their environment. Furthermore, 85% of the 221 residents living near the slaughterhouse use surface and groundwater for their domestic needs. The presence of pests is alarming: 92% of participants report seeing flies, 85% report seeing mice, and 78% report seeing cockroaches. Additionally, 63% of residents observe a degradation in the management of the slaughterhouse waste in recent years. These findings highlight the environmental and health risks associated with the effluents from the Mofolé slaughterhouse. Over 79% of disease cases reported in the last five years were linked to hygiene and water quality problems. Hence, emphasis should be laid on the need for a treatment system to ensure environmental and sanitary safety.

Keywords

Slaughterhouse, Effluents, Impacts, Management System, Mokolo

1. Introduction

The combination of rapid population growth and increasing demand for meat in developing countries is leading to an intensification of animal production, which produces considerable volumes of effluents. Slaughterhouses are emerging as key sources of these residues [9, 12] and African cities are

increasingly faced with the unprecedented environmental challenges associated with their effluents.

This waste, which includes solids such as hides, bones and viscera, as well as liquid effluents such as blood and sewage, contains a high concentration of contaminants, including

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pathogens, nutrients and organic substances. Indeed, effluent accounts for up to 50% of the weight of slaughtered animals [6]. These effluents, rich in nitrogen and phosphorus, contribute to water pollution. This situation is even more worrying given the lack of adequate management and treatment systems, which exacerbates environmental and public health problems in these regions.

In Cameroon, there is growing concern about the environmental consequences of slaughterhouse waste, particularly with regard to the contamination of water resources, which represents a crucial challenge [7, 16]. Effluent from slaughterhouses alters the quality of surface waters, introducing pathogens and harmful nutrients that harm aquatic life and make water unfit for human consumption. This problem illustrates the situation in the Municipality of Mokolo in the Extreme North of Cameroon, where residents suffer the repercussions of these discharges [14].

In addition, the decomposition of wastewater, effluent, contributes to soil contamination, releasing heavy metals and other pollutants that further affect the local ecosystem. The accumulation of organic matter in landfills also generates greenhouse gases, particularly methane, which exacerbates climate change and degrades air quality [2]. These environmental challenges underline the urgent need for proper management and effective treatment of slaughterhouse waste to reduce its harmful impact on the environment and safeguard the health of local residents.

The Mofolé slaughterhouse, the only cattle-slaughtering site in the Municipality of Mokolo, is a prime example of the impact of slaughterhouse waste on the local environment and public health. Slaughterhouse waste, such as non-consumable animal parts, wastewater, grease and sludge, entails risks of contamination, gives off unpleasant odors and attracts pests, etc [10]. The untreated discharge of this waste into the Mofolé river, or into the open air, causes significant pollution. Meanwhile, wastewater from such slaughterhouse more often contains pathogens such as bacteria, viruses and parasites, as well as decomposing organic matter, fats and oils [3, 13].

This pollution leads to a deterioration in water quality, affecting aquatic fauna and flora, and upsetting the balance of the local ecosystem [15] while local populations exposed to contaminated water are vulnerable to various diseases. Research findings show that slaughterhouse waste causes the proliferation of mosquitoes and flies, vectors of disease, and gives off foul odors that degrade quality of life and human health. Children, in particular, are severely affected by diseases such as diarrhea, typhoid, cholera and other infections directly linked to the contamination of water by slaughterhouse waste [8].

Although specific information sources concerning the Mofolé slaughterhouse are limited, similar situations have been documented in other regions. For example, a study of the Cotonou slaughterhouse revealed that untreated wastewater had harmful consequences on the health of inhabitants and the environment. Similarly, the Cuiseaux slaughterhouse in

France was the source of a large pollution load, exceeding the treatment capacity of the local wastewater treatment plant, which affected the quality of the water discharged into the natural environment [11].

This proximity of waste to drinking water sources exposes the inhabitants of Mokolo's to dangerous pathogens, mainly through the consumption of contaminated water. In addition, the inappropriate use of these waste products to fertilize agricultural crops further complicates the situation, increasing the risk of water- and food-borne diseases [4, 5]. It therefore becomes crucial not only to assess the environmental impact of slaughterhouse waste, but also to put in place effective strategies to prevent contamination of water resources and protect the health of local populations.

2. Materials and Method

2.1. Study Area

The study was carried out around the Mofol éabattoir, in the Mokolo municipality of the Far North Region of Cameroon. It focused on effluent discharge areas and surrounding natural resources (soil, watercourses, groundwater), (Figure 1).

The study area (Figure 1) below presents where the slaughterhouse is located, highlighting the geographical features of the region, including administrative boundaries and surrounding infrastructure. By visualizing the slaughterhouse's location in relation to waterways and residential areas, the figure provides a better understanding of the potential interactions between the slaughterhouse's activities and the local environment. This visual representation is essential for establishing a framework for analyzing the environmental and health impacts associated with the management of waste generated by the abattoir.

2.2. Data Collection and Analysis Techniques

Solid and liquid waste were identified to determine their composition in terms of organic matter, nutrients and contaminants such as pathogens and heavy metals. Interviews were conducted with the local population to assess perceived impacts. Soil was analyzed for organic matter, nutrients and contaminants, while water was checked for organic load, nutrients and pathogens.

To determine the appropriate sample size for the study on the environmental and health impacts of the Mofolé slaughterhouse effluents, a rigorous sampling methodology was adopted, segmenting the population into five groups: nearby households, health officials, slaughterhouse staff, local and municipal authorities, and community organizations. Stratified random sampling was used to ensure data representativeness, given that the site has approximately 650 individuals identified within households (PCD Mokolo, 2023). The required sample size was therefore calculated using Cochran's

formula, as follows.

$$n = \frac{N \times Z^2 \times p \times (1-p)}{(N-1) \times E^2 + Z^2 \times p \times (1-p)}$$

Where:

- n = Sample size
- N = Population size (650)
- Z = Value of the normal distribution for the desired confidence level (e.g., 1.96 for 95% confidence)
- p = Estimated proportion of the characteristic studied.
- E = Acceptable margin of error (for example, 5% or 0.05)

By applying these values, we obtain:

$$n = \frac{650 \times 1.96^2 \times 0.5 \times (1-0.5)}{(650-1) \times 0.05^2 + 1.96^2 \times 0.5 \times (1-0.5)} \approx 242$$

In this way, some 242 households in the vicinity are suitable for interview.

For the other groups, given their potentially small size, the exhaustive approach was adopted by interviewing all available professionals in the study area notably: health officials (5), slaughterhouse staff (5), local authorities (DDEPIA, Council) (5) with the interviewing of all relevant representatives, local organizations (5).

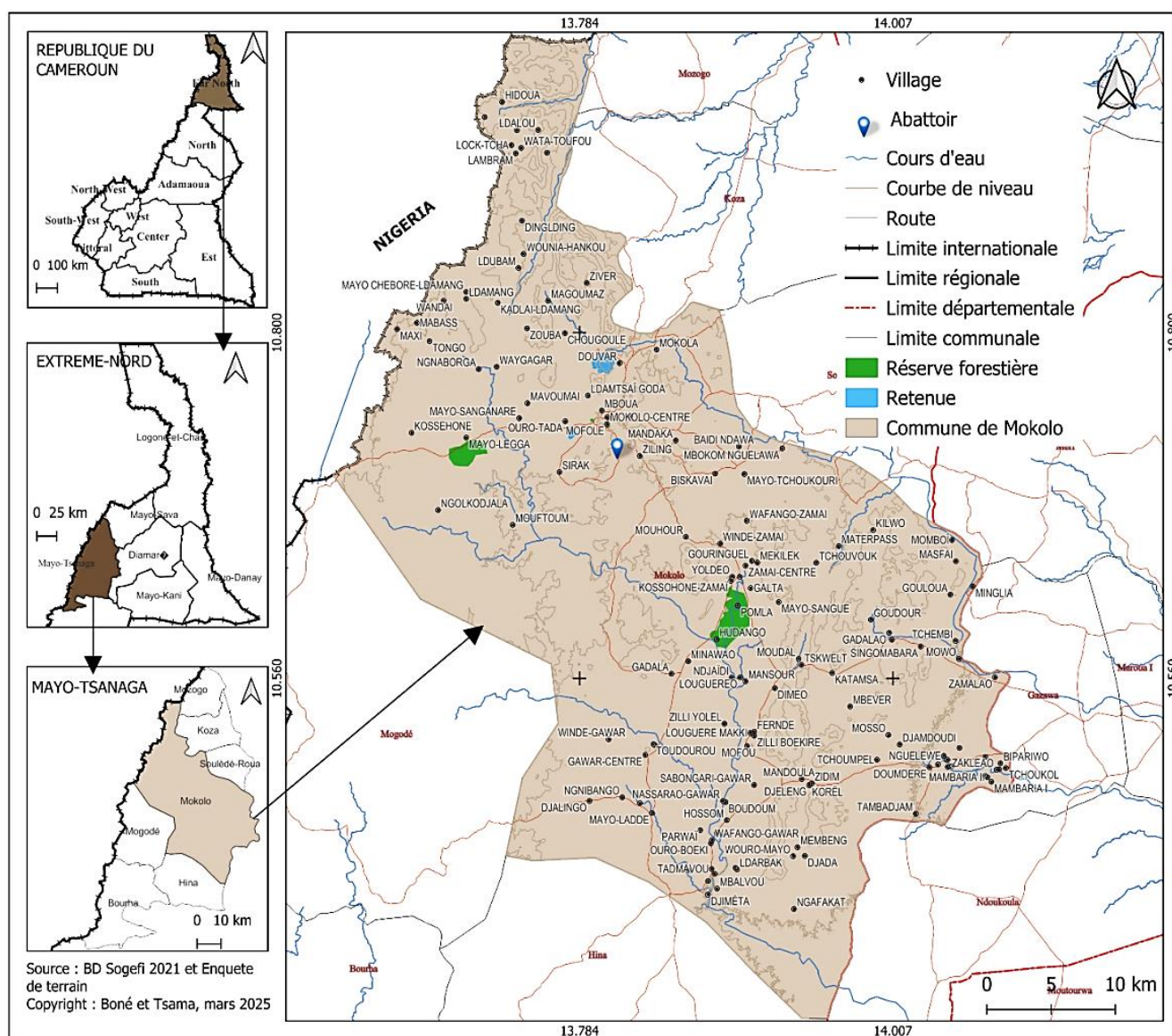


Figure 1. Location of study site.

3. Results and Discussion

3.1. Socio-Demographic Characteristics of Respondents

Information on the gender, age and role of respondents in the household was used to characterize individuals with a

direct or indirect link to the abattoir. Analysis of the questionnaire responses revealed that the majority of respondents (62%) were women. This can be explained by the fact that there are more women than men in most households in the locality. In terms of age distribution, the most representative age group was 31-40, with a majority of women having a more or less direct link with the abattoir (Figure 2).



Figure 2. Distribution of respondents by age group.

The figure above shows that the majority of respondents (142, or 54.20%) belong to the 31 to 40 age group, followed by 79 (30.15%) aged 21 to 30. Participants over 50 years of age account for 23 individuals (13.36%), while those under 20

years make up the smallest proportion, with only 6 respondents (2.29%). The distribution of inhabitants indicates a relatively stable community, with a significant proportion of new arrivals over the last two (2) decades, as shown in Figure 3 below.



Figure 3. Distribution of duration of respondents living near the abattoir.

The pie chart shows that the majority of respondents have been living or working near the Mofolé abattoir for many years, specifically between 11 and 20 years (34.35%), while those with less than 10 years accounted for 31.68%. Long-term residents who have been present for 31 to 40 years represented 19.85%, whereas those with 21 to 30 years made up 13.36%. Only 0.76% of participants have lived in the study area for 41 to 50 years, and none for more than 50 years.

These data suggest an intensive and regular use of the area around the abattoir by the residents, with 79.77% of them frequenting the areas around the abattoir on a daily basis,

while 17.94% visit them on a weekly basis. A minority (2.29%) visit on a monthly basis, and no participant reported annual frequency or no visits at all.

3.2. Management System and General Characterization of Slaughterhouse Waste

All respondents were well aware of the existence of the Mofolé slaughterhouse, with no participant reporting even partial ignorance of the facility. These results indicate full awareness of the abattoir, suggesting a long-standing famili-

arity with its activities, as shown in Figure 4 below.



Figure 4. Mokolo slaughterhouse (Mofol é).

The above photos (Figure 4) illustrate the Mokolo slaughterhouse, located in Mofol é. It highlights the infrastructure, comprising two main buildings, that support slaughterhouse operations. The images also show the various activities carried out on site, such as slaughtering. This visual representa-

tion provides a better understanding of the scale and operation of the facility in the local context.

Effluent management at this facility is essentially informal, with limited recovery practices, leading to environmental and health risks (Figure 5).

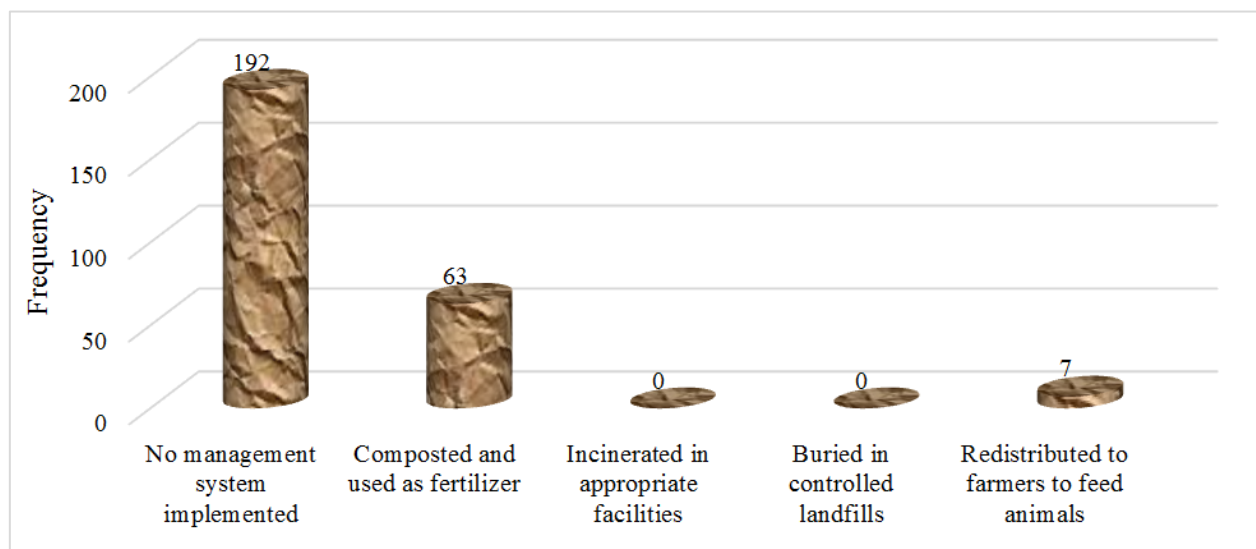


Figure 5. Waste management system at the Mokolo slaughterhouse.

This histogram shows that 73% of effluent from this abattoir do not go through any management system. Furthermore, 24% of waste is composted and used as fertilizer, while only 2.67% is redistributed to farmers for animal feed. There is no

mention of incineration in appropriate facilities or deposition in controlled landfills. This highlights the total absence of any effluent and waste treatment or disposal system on site (Table 1).

Table 1. *Inexistence of a waste treatment system at the abattoir.*

Value	Frequency	Percentage
No discharge or treatment system implemented	259	98,86
Discharged directly into municipal sewers, waterways, open spaces, etc	3	1,14
They undergo preliminary treatment on site before discharged in the environment	0	0
They are sent to a specialized wastewater treatment plant	0	0
They are treated by bio-filtration processes	0	0
They are recycled and used for other industrial processes	0	0

Source: Field surveys, 2025

This matrix highlights the absence of any effluent disposal or treatment system at the Mofol é slaughterhouse with over 98% of respondents while effluent discharged directly into the open air or into watercourses accounts for 1.14%. No other method of treatment or disposal is mentioned, highlighting a significant lack of appropriate effluent management, leading to significant environmental and health impacts.

Similarly, there is no waste collection system in place, exacerbating effluent management problems. This lack of an organized structure hinders efficient waste disposal and contributes to the degradation of the local environment (Table 2). This underscores the urgent need for intervention to establish sustainable solutions.

Table 2. *Inexistence of a waste collection or treatment system at the abattoir.*

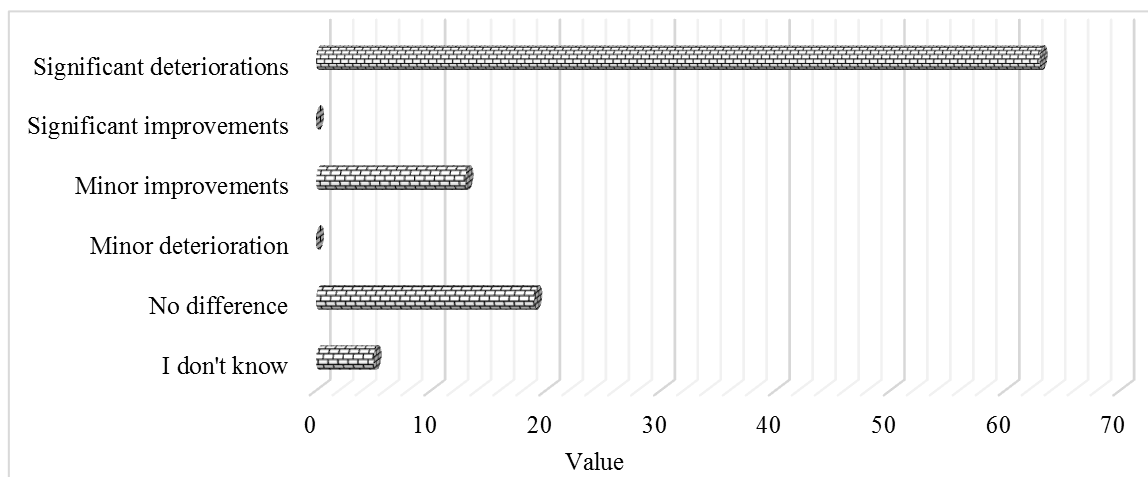
Value	Frequency	Percentage
No, there is no organized waste collection system at the slaughterhouse.	201	76,72
Yes, there is a centralized collection system for all waste.	61	23,28
Yes, specialized companies manage waste collection and processing.	0	0
Yes, the system uses refrigerated trucks to transport waste.	0	0
Yes, processing is carried out on site with waste reduction facilities.	0	0

Source: Field surveys, 2025

The absence of an organized waste collection system at the Mofol é slaughterhouse is noted by over 76% of the respondents, while 23% cite the existence of a centralized collection system and none reports of the involvement of specialized companies, the use of refrigerated trucks or on-site processing with dedicated facilities. This situation suggests insufficiently structured waste management, leading to environmental and health risks.

With regard to the maintenance department, the results indicate a similar situation, with 31% of respondents reporting

the absence of a person responsible for waste management at the abattoir. On the other hand, 23% confirmed that there was a clearly designated person in charge. A further 18% mentioned a person in charge whose presence was irregular, while 29% did not know if there was a person in charge. These results reflect a mixed perception of waste management, with a significant proportion of the community either unsure or aware of the lack of adequate supervision. This contrasts with the 62%-plus deterioration in waste management observed in recent years (Figure 6).



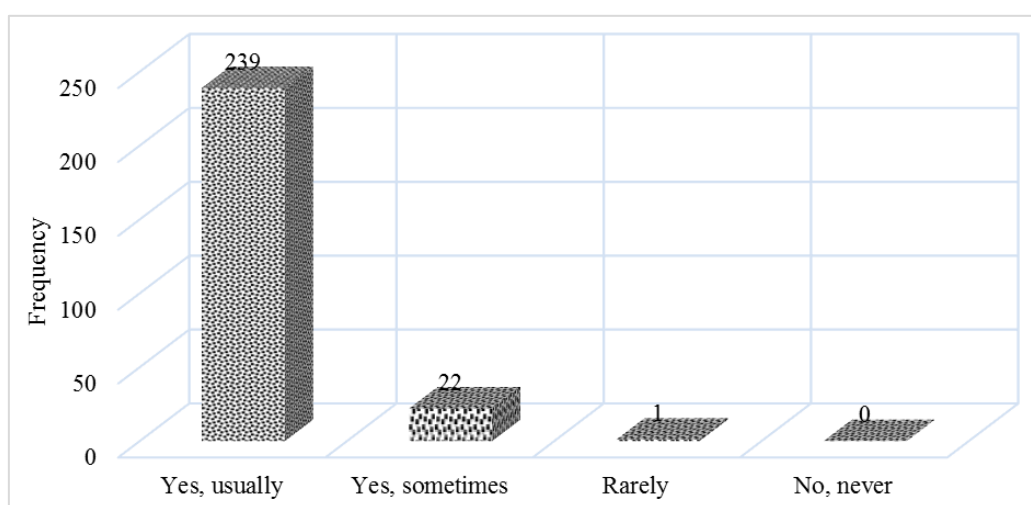
Source: Field surveys, 2025

Figure 6. Assessment of changes in the state of the environment around the slaughterhouse.

Figure 6 shows that significant deterioration in waste management at the slaughterhouse in recent years is noticed by 63% of residents. On the other hand, minor improvements were reported by 13%, while 19% of respondents noticed no difference. No significant improvements or minor deterioration were reported, and 5% of participants did not know if any

changes had taken place.

These results show a predominantly negative perception of changes in waste management at the Mofol é abattoir. This is partly explained by the worrying presence of waste from the abattoir in nearby residential areas, as shown in Figure 7.



Source: Field surveys, 2015

Figure 7. Pollution of neighboring residences by abattoir waste.

The majority of residents, 239 people (91.22%), regularly see slaughterhouse waste in their neighborhoods or surroundings. This situation illustrates a persistent waste management problem, affecting residents' quality of life and raising health concerns. A smaller group, made up of 22 residents (8.40%), indicated that they see this waste only sometimes, suggesting variable exposure according to time or area. On the other hand, a very small proportion (0.38%) reported that they rarely noticed litter. These observations

highlight the negative impact of the abattoir on the local environment, and underline the need for intervention to improve waste management.

3.3. Major Impacts of Slaughterhouse Effluents

Slaughterhouse waste has a number of impacts, notably on the environment and health.

3.3.1. Environmental Aspect

The environmental aspect of slaughterhouse waste has a significant impact on soil and water, including surface water and groundwater. These elements play a crucial role in the dissemination of bacteriological and chemical agents. Indeed, water contamination leads to health problems for humans and wildlife, affecting the ecosystems. The results of the survey reveal that 99.6% of the study population noted that wastewater from the slaughterhouse is discharged into nature or watercourses, highlighting the scale of this problem (Table 3).

Table 3. Inadequate management of slaughterhouse wastewater.

Value	Frequency	Percentage
In the streams	262	99,62
In the open or nature	262	99,62
In the space for possible treatment	1	0,38

Value	Frequency	Percentage
No idea at all	10	3,38

Source: Field surveys, 2025

It's clear that almost all local residents (99.62%) believe that wastewater from the slaughterhouse is discharged directly into waterways or the natural environment. This raises serious concerns about the environmental and health impact of this practice. Only a minority (0.38%) of respondents believe that there is space provided for the treatment of this wastewater. What's more, 3.82% of participants don't know how this water is managed, revealing a lack of information about the situation. This uncertainty heightens anxiety in the community seeking for answers on how to manage local waste resources.

Figure 8 below, clearly illustrates the problem of slaughterhouse wastewater being discharged into the environment, highlighting the crucial issues linked to environmental protection and public health.

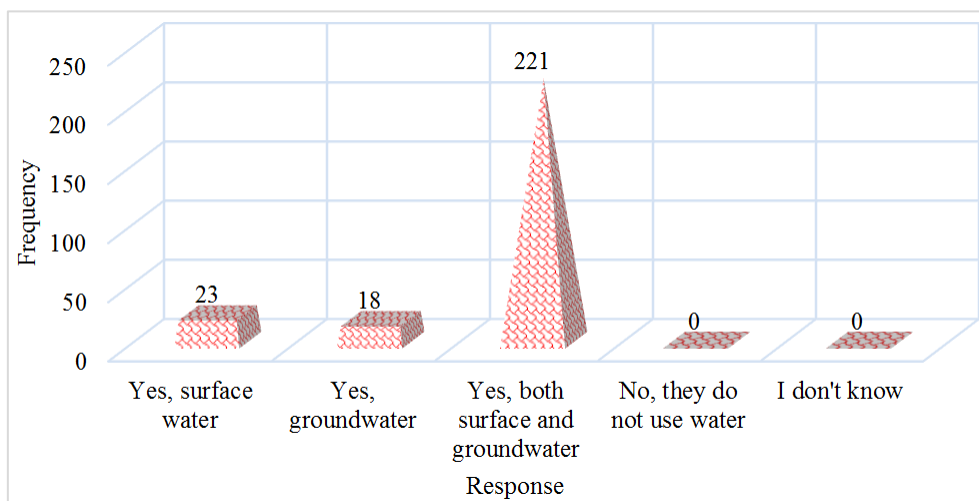


Figure 8. Direct discharge of slaughterhouse wastewater without prior treatment.

Observations are indicative of significant effluent discharge from the local environment, probably due to direct discharge of slaughterhouse effluent without prior treatment. For more than a decade, signs of pollution in surface waters near the slaughterhouse have been visible, notably through changes in color, bad odors and the presence of foam amongst others.

Such practices only lead to a reduction in dissolved oxygen, affecting aquatic life, and promoting eutrophication, disrupting the ecological balance of watercourses.

Meanwhile, local populations use the surface and/or groundwater near the slaughterhouse for their daily needs (Figure 9).

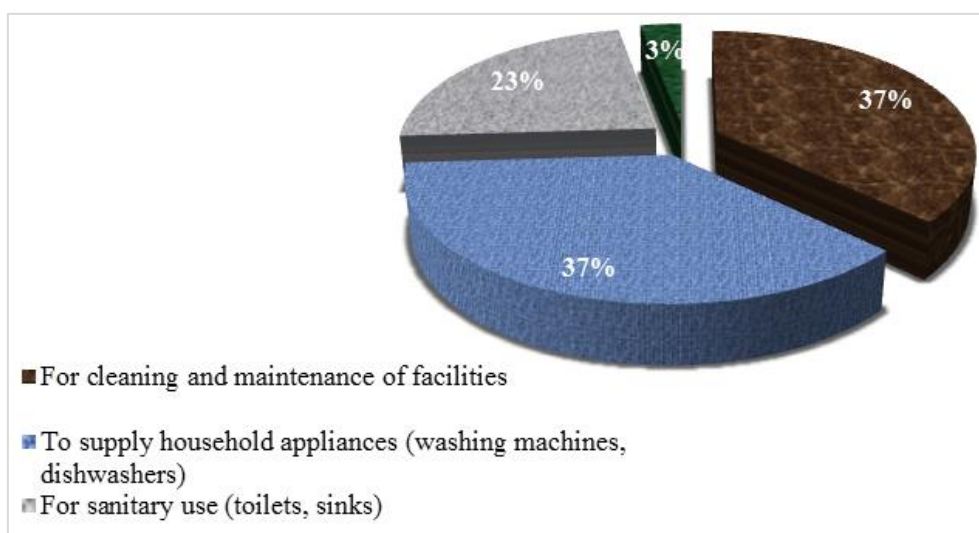


Source: Field surveys, 2025

Figure 9. Surface and groundwater use in the abattoir vicinity.

Figure 9 above shows that the majority of residents (221) in the vicinity of the abattoir, that is, 85%, use both surface and groundwater for their domestic needs. Only 7% of respondents use surface water exclusively, while 6% prefer groundwater. None of the respondents stated that they did not use these water resources.

This mixed use of local water sources is a cause for concern, especially in view of the surface water pollution reported near the slaughterhouse, raising serious public health concerns, not least because these waters are used for domestic tasks (Figure 10).



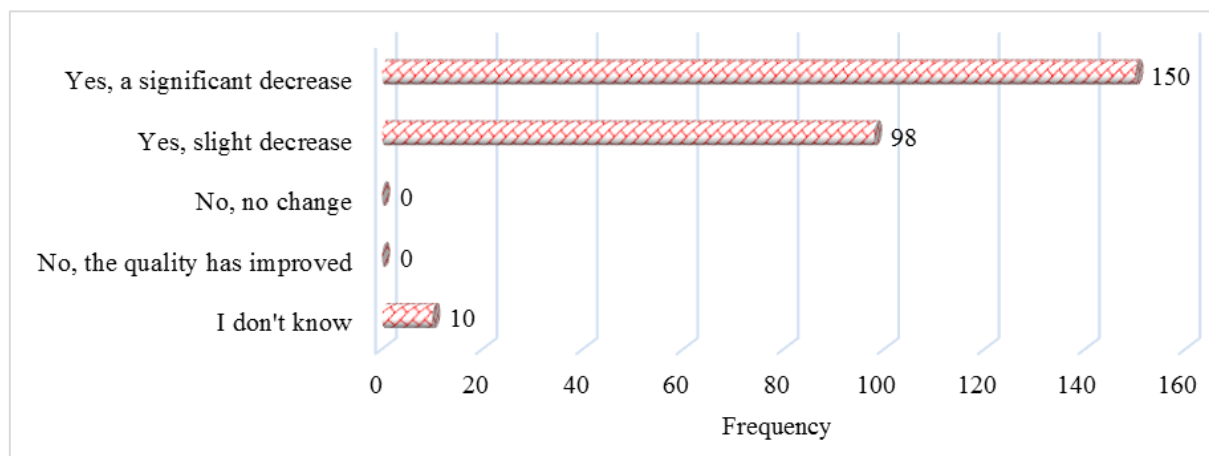
Source: Field surveys, 2025

Figure 10. Proportions of domestic surface and groundwater use near the abattoir.

Surface and groundwater near the slaughterhouse are mainly used for cleaning and supplying household equipment, each accounting for 37% of usage. On the other hand, their use for sanitary and irrigation purposes is much less frequent, underlining a significant dependence on these resources, despite the associated risks. This situation exposes the popu-

lation to health hazards, especially due to the pollution reported in the soil.

As a result, deterioration in water quality is evident, as indicated by notable changes in the taste, smell and color of well and river water. This information is illustrated in Figure 11, which highlights the extent of the problem.



Source: Field surveys, 2025

Figure 11. Major impact of the slaughterhouse on surface water quality.

The decline in water quality (taste, smell, color) in wells or rivers is significant (150). This observation is a cause for concern; as such, degradation has serious consequences for public health and the local environment. There is evidence that slaughterhouse effluent, rich in organic matter and pathogens, pollutes groundwater and nearby watercourses, affecting the quality of drinking water and aquatic ecosystems.

The results accentuate that 62% observed significant changes in water or soil quality around the slaughterhouse, while 35% noted minor modifications. No respondent ob-

served any change at all, and only 3% remain uncertain. These backlashes instill a unanimous perception of environmental deterioration linked to slaughterhouse activity, underlining the need for intervention to improve waste management and protection of the environment.

The proximity of the discharge zones leads to excessive accumulation of nutrients in the soil, causing eutrophication phenomena, aggravated by the presence of pathogens such as *E. coli* and *Salmonella spp.* in the surrounding area, and posing serious risks to the population (Figure 12).

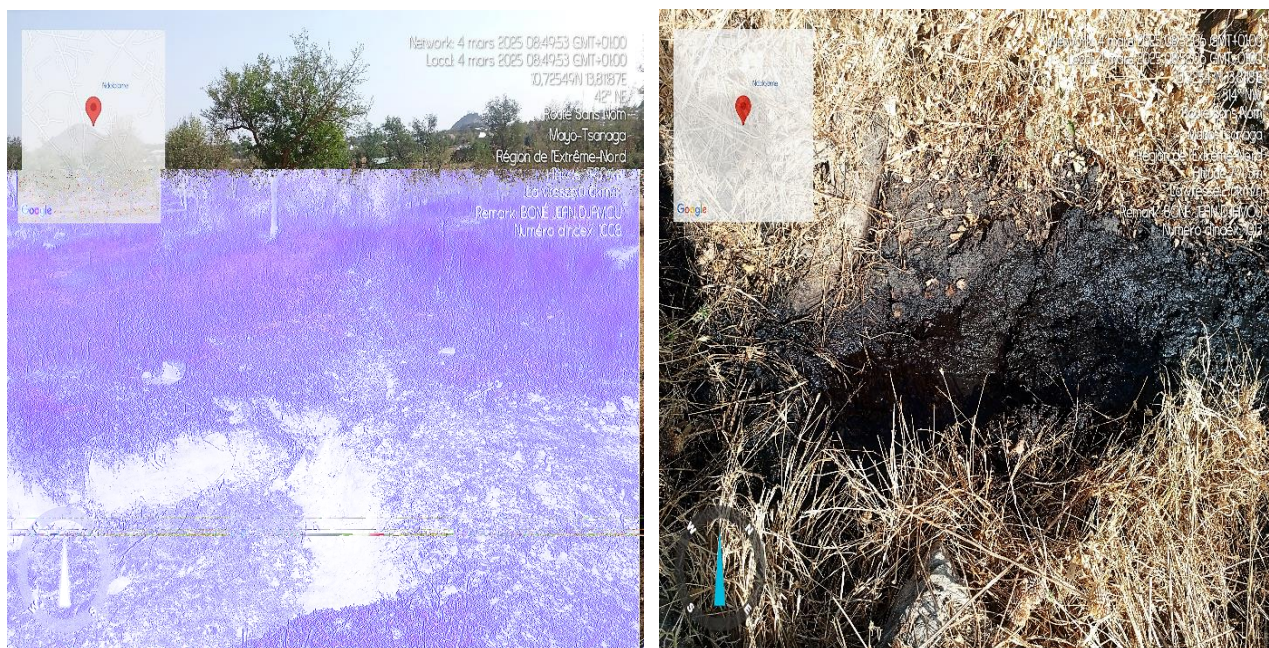


Figure 12. Soils in the Slaughterhouse area affected by eutrophication.

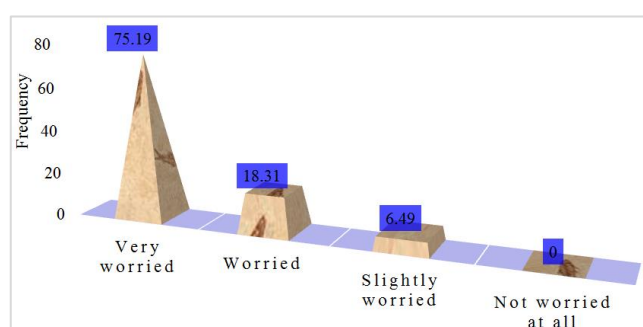
Figure 12 illustrates soils in the Abattoir affected by eutrophication, caused by excess nutrients from slaughterhouse

effluent. This excess reduces dissolved oxygen in the water, threatening aquatic fauna and causing a decline in biodiversity.

In addition, eutrophication upsets the balance of watercourses and encourages the proliferation of harmful algae.

The survey reveals that a majority of Mofol é residents (86.98%) point the finger at animals, both domestic and wild, and to slaughterhouse wastes, indicating a strong environmental and health concern. Only a small percentage (0.76%) feel that it never has an impact, highlighting the importance of slaughterhouse wastes management for animal health and biodiversity.

Another major concern is the mortality rate of fish and other aquatic animals near the slaughterhouse, which reaches 72% with frequent cases. This raises considerable concerns about the impact of abattoir waste on the environment, as shown in Figure 13.



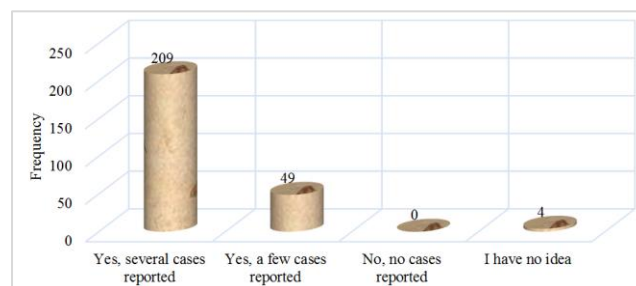
Source: Field surveys, 2025

Figure 13. Residents' level of concern about the impact of abattoir effluent.

The majority of households (75%) express great concern about slaughterhouse waste in their environment. Concern is high for health and environmental protection, with only 18% expressing concern, while a minority (6%) express little concern, prompting immediate action to improve slaughterhouse waste management.

3.3.2. Health Aspects

The increase in water-borne diseases, such as cholera, diarrhea and typhoid, is a major concern in the locality, where access to drinking water and adequate sanitary facilities is still inadequate. The results of this survey show that over 79% of disease cases reported over the last five years are linked to hygiene and water quality problems, as summarized in Figure 14.

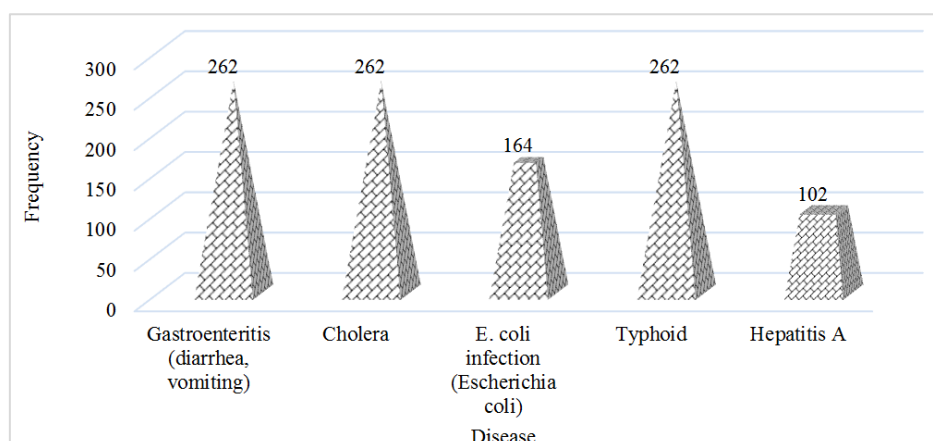


Source: Field surveys, 2025

Figure 14. Diseases reported by local populations.

The high prevalence of health problems linked to contaminated water in the community is evident as majority (80%) reported several cases of illnesses linked to contaminated water, while 19% report a few cases. This situation highlights the urgent need to improve drinking water supplies and develop sanitary infrastructures to protect public health.

Without appropriate measures, the population remains vulnerable to new epidemics, compromising their well-being and quality of life. Most cases are linked to diseases such as typhoid, gastroenteritis and cholera, which are attributed to the effects of slaughterhouse waste (Figure 15).



Source: Field surveys, 2025

Figure 15. Health risks associated with water quality.

Consumption of contaminated water is associated with illnesses such as gastroenteritis, cholera and typhoid, with a unanimous perception of these conditions reaching 100%. As for *E. coli* infections, these were reported by around 62.6% of respondents, while 39% mentioned cases of Hepatitis A. These data reveal significant vigilance on the part of the community with regard to health risks linked to water quality.

The proliferation of insects and pests, such as flies and rats,

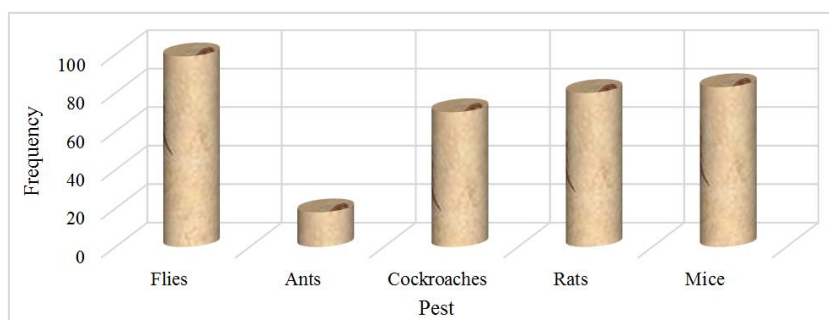
causes serious public health problems and affects quality of life. These pests transmit diseases and contaminate foodstuffs, increasing the risk of infection. Favorable environmental conditions, such as stagnant water and poor waste management, encourage their reproduction. Areas where sewage stagnates have become havens for pigs and dogs, which then transport these insects and pathogens from these sites to homes (Figure 16).



Figure 16. Effluent stagnation and pathogen transport.

The photographs (Figure 16) illustrates effluent stagnation, which creates an environment conducive to the reproduction of dangerous pathogens. Insects and pests multiply in this wastewater, facilitating the spread of disease and attracting animals such as pigs. The latter carry pathogens on their

bodies and legs to homes and spaces frequented by humans. This situation considerably increases the health risks for the population, which explains the continuing rise in the number of pests in households (Figure 17).



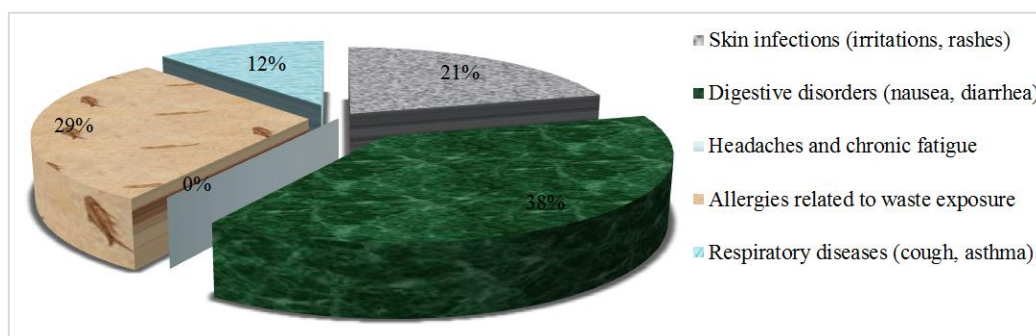
Source: Field surveys, 2025

Figure 17. Impact rate of various pests in the locality.

The presence of flies reported by 92% of the respondents and mice (85%) highlight a potential pest problem in the surveyed environment. Over three-quarters of survey participants reported the presence of cockroaches (78%). Ants, on the other hand, are much less frequent, with only 20% of respondents mentioning them. This proliferation of insects and pests affects and/or reduces the local population's way of

life.

It is clear, then, that household complaints about health problems such as respiratory ailments, infectious diseases and other health disorders linked to environmental pollution caused by slaughterhouse waste. The results reveal unanimity among local population about the harmful effects of this waste on their health (Figure 18).



Source: Field surveys, 2025

Figure 18. Frequency of reported health problems in the survey area.

The percentages shown are very high, indicating a high prevalence of health problems reported by respondents. Digestive disorders (38%) and skin infections (21%) are of particular concern, suggesting unfavorable environmental conditions. In-depth studies are needed to identify the underlying causes and propose remedial measures.

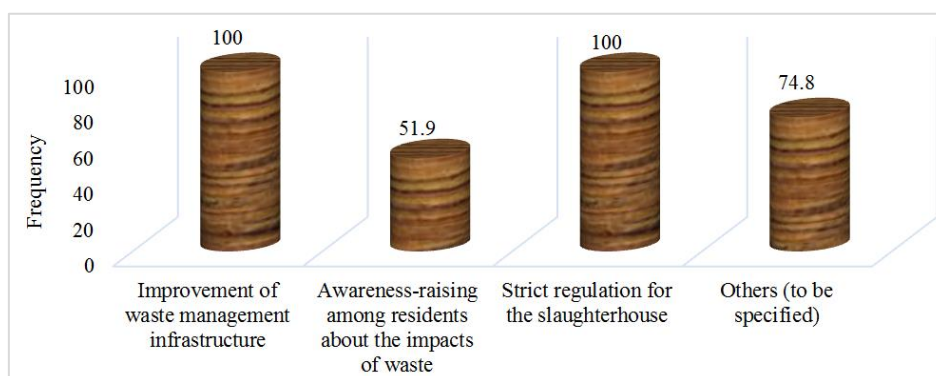
Similarly, a large majority of slaughterhouse employees (56%) use protective equipment only sporadically, while a notable proportion (37%) never use it at all. This raises concerns about safety in the workplace, as only 6% claim to use such equipment on a regular basis. The low percentage of those who don't know (2%) reflects a lack of information on safety practices. These results highlight the urgent need to improve safety standards in this sector, and call for immediate action to optimize slaughterhouse effluent management.

3.4. Optimizing Waste Management at the Slaughterhouse

It is clear from the various points raised that there is a significant problem with effluent management at the Mofolé slaughterhouse. Indeed, the alarming finding is that 83% of

households have never taken steps to protect themselves against exposure to abattoir waste, which raises questions about the level of awareness on this subject. Although 21% claim to take action on a regular or occasional basis, this reflects a flagrant lack of general commitment, revealing a lack of awareness of the environmental and health repercussions associated with slaughterhouse waste. Faced with this worrying situation, an awareness-raising campaign could prove beneficial in promoting more responsible behavior, especially as over 92% of those surveyed said they would be willing to benefit from or take part in one.

On the other hand, on the local government side, the majority of households perceive the municipality's actions in slaughterhouse waste management in a negative light, with 70% deeming these efforts “not at all effective”. This indicates an urgent need for improvement in waste management, as only 0.8% of respondents consider these actions to be “very effective”, reflecting a lack of confidence in current initiatives. It is therefore crucial that the mayor's office considers more effective strategies, seeking out partners and involving the local population to a greater extent, in order to reinforce the effectiveness of the measures put in place (Figure 19).



Source: Field surveys, 2025

Figure 19. Approaches to optimizing slaughterhouse management.

Figure 19 highlights that almost all survey participants (100%) recognize the importance of improving waste management infrastructure and implementing strict regulations for the slaughterhouse. This demonstrates a strong demand for concrete, effective action. Although a majority supports raising residents' awareness, it seems to be regarded as secondary, indicating that tangible measures are considered a priority. In addition, the significant number of responses under the "Other" category suggests that there is a diversity of ideas and approaches worth exploring for optimal waste management.

These values far exceed the standards for the disposal of slaughterhouse waste in receiving environments. This represents a risk of environmental pollution, hence the need for treatment before any discharge into the environment. Hence, biological processes adapted to high organic loads therefore treat this effluent is very much in need in this surveyed area. The load can be reduced using a high-load aerobic reactor or an anaerobic digester. This process is therefore introduced in a "classic" scheme before activation of the sludge tank or biofilter, for example. The ultrafiltration or nanofiltration unit can also be installed after the high-load reactors to ensure vacuum quality. Heavy loads can also be treated with reagents that enhance the metabolism of organic matter via biomass, or by adding flocculants to precipitate organic matter. The physical and chemical properties of slaughterhouse waste play a crucial role in its treatment. If the effluent is biodegradable, biological treatment can be envisaged. It is treated with activated sludge.

In addition, converting organic waste into biogas or fertilizer, as well as recycling bones and hides for local crafts, could be valuable assets for the abattoir.

4. Discussion

The specific data from the Mofolé slaughterhouse is very likely to reflect the challenges faced by other slaughterhouses in the Far North of Cameroon. Throughout the country, the lack of adequate waste management has led to major environmental and health problems, such as pollution of water and air resources.

There is no transformation or effective treatment system for all the various waste produced in Mofolé slaughterhouse. Hence, management of effluents from slaughterhouses is usually inadequate. This situation has serious consequences for both the environment and the health of the local population. Indeed, livestock slaughterhouses in Cameroon generate large quantities of liquid and solid wastes, without having the means to treat them appropriately. This raises concerns not only for the people living nearby, but also for the surrounding ecosystems, which are adversely affected by this situation. This study corroborates with those of other authors in different parts of the world on water quality affecting aquatic lives [15], life quality and human health of inhabitants [8, 11].

The research carried out on this topic by various authors sheds valuable light on the issues involved in slaughterhouse waste management. The results of these studies clearly indicate that the waste generated by the Mofolé slaughterhouse has significant environmental impacts, including a deterioration in soil and water quality in the surrounding area. These results concur with the work of [1], who examined the impacts of abattoir effluents on surface water quality, highlighting increased contamination of these valuable resources. In parallel, [2] took this issue further by analyzing the adverse effects of slaughterhouse waste on the environment, highlighting that soil pollution and health risks stem from inadequate waste management, both solid and liquid. This research highlights the urgent need to improve waste management practices in the slaughterhouse sector to protect ecosystems and public health, taking into account the interdependence between water and soil quality and the well-being of surrounding communities.

Slaughterhouse effluent poses a considerable risk, contaminating both surface water and groundwater. [14], whose research focused on the contamination of water resources by abattoir effluents, highlighted major implications for public health, also highlight this issue. The population of Mofolé is equally worried when these effluents are indiscriminately discharged into the environment, notably into watercourses, leading to a high microbial load from abattoir wastewater, as well as a negative impact on soil quality.

Studies by [3, 4] highlight the health risks associated with the presence of pathogens in these effluents, which can lead to diseases in the local communities. Furthermore, the environmental and health consequences of unhygienic practices in urban slaughterhouses are clearly visible, as [5] point out, revealing alarming levels of pollution of soil and aquatic resources, and calling for an urgent reassessment of waste management practices in this critical sector.

The health impacts of waste from slaughterhouses are particularly alarming. Indeed, these findings concur with those of [12], who assessed the effects of abattoir effluents on groundwater quality, highlighting that these wastes present significant risks to human health, as also indicated by [9]. It is essential to emphasize that slaughterhouse waste discharges affect surface water quality, highlighting the environmental and health challenges engendered by inadequate management of these wastes. This issue corroborates the work of [6], who reveal the adverse consequences for public health and the environment, calling for urgent reforms of slaughterhouse waste management practices to protect the health of communities and the quality of water resources.

Evidently, [16] analysis of wastewater from the Étoudi slaughterhouse is in line with these results. He also demonstrates that, in view of the harmful effects of this effluent on the environment and on humans (toxicity, eutrophication, contamination of receiving ponds, contamination and pollution of groundwater, propagation of water-borne diseases),

present high levels of the main physico-chemical parameters. This is indicative of organic pollution which significantly exceed the limit values for direct and indirect discharge into the receiving environment. Hence, constituting a major source of pollution for the environment in general and the waters of the Ako'o stream in particular [7]. For this reason, this author believes that slaughterhouse wastes should be purified before discharge. What is even more are the risks associated with these discharges from the slaughterhouse are obvious for the health of the population, which undoubtedly lead to numerous bacterial and viral infections. These findings underline the urgent need for coordinated action to minimize the associated risks and ensure a healthier environment for all in the Mokolo Municipality.

5. Conclusion

The Mofolé slaughterhouse is a major source of pollution due to poor effluent management, as revealed by a survey of 262 local residents. This poor management, with 73% of participants rating the system as almost non-existent and 98% of waste untreated, creates serious environmental and health risks for the local population. Untreated effluent contaminates soil and water, threatening the health of local residents calling for urgent action to reduce this pollution, in particular by implementing appropriate wastewater treatment systems and good waste management practices in the agricultural sector, for example. This will not only mitigates the environmental impact of the slaughterhouse, but also generates socio-economic benefits, such as job creation and the development of a circular economy. Concerted action is essential to protect the environment and the well-being of local residents, while promoting the sustainable development of the region.

Abbreviations

DDEPDED	Divisional Delegation of Environment, Protection of Nature and Sustainable Development
DDEPIA	Divisional Delegation of Livestock, Fisheries and Animal Industries

Author Contributions

Valerie Tsama Njitat: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Resources, Supervision, Validation, Writing – review & editing

Boné Jean Djamou: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – original draft

Julius Kajoh Boyah: Visualization, Writing – review & editing

François Victor Nguetsop: Supervision, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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