Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6, 917-936
2024
Publisher: Learning Gate
DOI: 10.55214/25768484.v8i6.2186

Urban governance and solid household waste management in Togo: Case of the town of Vogan in Togo (West Africa)

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Abstract: The regular growth of the population and the change in consumption patterns lead to significant production of urban waste, the management of which is becoming an environmental concern. The rapid population growth and changing consumption patterns have led to significant urban waste production, making waste management a pressing environmental concern. This study aims to improve solid household waste management in Vogan through a diagnostic analysis. Conducted from June to August 2022, the cross-sectional study surveyed household knowledge, attitudes, and practices related to waste management. Data were collected through an opinion survey of 350 households across 20 districts, using semi-structured questionnaires, interviews, and field observations. Additionally, heavy metal content in waste samples was analyzed in the laboratory. Results showed that 85.43% of households had trash cans, yet 62.26% disposed of their waste in illegal dumpsites due to a lack of pre-collection services. Furthermore, 10.57% used waste as backfill in streets. Knowledge about waste management was moderate, with 62.29% having heard of it, and 70% of these respondents recognizing the importance of subscribing to a pre-collection service. Laboratory analyses revealed contamination of a landfill with cadmium, lead, and copper, along with widespread zinc pollution across all selected sites. Raising awareness and installing proper waste management infrastructure are critical to improving public health and enhancing the town's environmental quality.

Keywords: *City of Vogan, Management, Sanitation, Solid household waste, Sustainable development.*

1. Introduction

The regular growth of the population and the change in production and consumption patterns lead to an increasingly significant production of waste of a very varied nature such as waste from households, industrial units, businesses, healthcare activities, building, cleaning services, green spaces, and agriculture [1, 2]. The various methods of managing these different wastes contribute to the release into the environment of potentially dangerous substances which raise multiple questions about their risk for human health [1]. Waste management is indeed a major problem worldwide. It poses both an environmental and public health problem. These problems are taking an important place every day in the various debates on sustainable development and constitute a major concern for both developed and developing countries. Therefore, the question of the environment is at the heart of several international

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meetings [3]. In Western countries, the question arises in terms of the effectiveness of existing waste disposal methods, while in Africa, few countries are really interested in existing management methods. In large African cities we are witnessing a proliferation of illegal dumping of household waste on public roads and spaces, along waterways and near homes. This garbage constitutes a potential source of so-called environmental diseases because it is closely linked to the state of environmental degradation [4, 5]. Urban waste management is therefore one of the environmental issues of most concern for developing countries. The lack of knowledge of the populations or their ignorance on the subject, the insufficiency of financing and the institutional framework, as well as the lack of infrastructure, equipment and reliable data, contribute to accentuate the difficulties encountered in the management of waste [6]. Togo, a country in West Africa, with an estimated population of 7.6 million in 2020, also faces this challenge [4]. Indeed, in terms of sanitation and safety, households do not use a healthy method of evacuation; 39.8% of households throw household waste into nature, including 24.9% in wild dumps [2, 7, 8]. The production of DMA (Direct Memory Access) estimated in 2014 at 311,000 tonnes/year with a population of 1,685,000 inhabitants increased in 2015 to 316,000 tonnes/year then in 2020 to 352,000 tonnes/year with respectively a population of 1,709,000 inhabitants and 1,904,000 inhabitants [4]. Vogan, capital of the commune Vo1, with a population increasing from 1078 inhabitants in 2010 to 15983 inhabitants in 2021, is not spared from this scourge [9, 10]. The increase in population and the progressive urbanization of this locality have obviously been accompanied by a massive production of waste resulting in the birth of illegal dumps, particularly in the streets, neighborhoods and near markets. Added to this situation are dumping of solid waste in places as embankments as well as open defecation, particularly around the large market [11]. With a view to implementing a waste management strategy in the various municipalities in view of the decentralization process underway in the country on the one hand, and on the other hand, responding to target 12.5 of the SDGs (Sustainable Development Goals) according to the principle of the wheel of the three R's, "By 2030, considerably reduce waste production through prevention, reduction, recycling and reuse", it is essential to have data on the theme at the level of each locality [12]. It is in this context that this study takes place, which is a decision-making contribution, by providing data on the management of household and similar waste in the town of Vogan. To do this, we have set ourselves the general objective of contributing to better waste management in the town of Vogan. More specifically, it involves: (i) describing the solid waste management methods existing in the town of Vogan; (ii) assess the level of knowledge of the population on the management of this waste in this City; (iii) determine the trace metal element content of waste from some landfills in this city; (iv) propose actions to improve solid waste management in the city of Vogan.

2. Material and Methods

2.1. Study Framework

Geographical Setting: Located 55 km from Lomé the capital, the town of Vogan, capital of the prefecture of Vo and at the same time that of the commune Vo1 (220.61 km ^{2} or 0.38% of the surface area of Togo) constitutes the specific framework of our study [9, 10].

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 917-936, 2024
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Figure 1.
Map of the commune of Vo1.

Scientific Framework: The laboratory of biomedical, agri-food and environmental health sciences (LaSBASE) of the University of Lomé (UL); the clinic for societal educational expertise, policy and development objectives (CEESPOD) of the African Institute of Biomedical, Agrifood, Societal and Environmental Sciences (IASBASE) and the environment and geoscience laboratory of the Faculty of Sciences (UL) served as a technical and scientific framework for our study.

2.2. Study Material

For the opinion survey, households, more precisely heads of households, were the target of our work. To do this we used recording media (Semi-structured questionnaire, interview guide, observation grid, notepad, writing desk, digital photo, etc.). For laboratory analyses, the fine fraction of waste from landfills (soil or ashes) constituted the biological material. We used equipment (spectrophotometer, electric balance, pipettes, glasses,) and consumables (distilled water, hydrochloric acid, nitric acid, tips, bottles, gloves, etc.)

2.3. Study Method

2.3.1. Type and Period of Study

This was a cross-sectional study with a descriptive and analytical aim running from June to August 2022 in the town of Vogan (commune Vo1) on household knowledge, attitudes and practices regarding the management of solid and liquid household waste. in the locality. Waste samples were also taken from illegal dumpsites with a view to determining their heavy metal content in the laboratory.

2.3.2. Techniques and Tools

The techniques and tools are presented in Table 1.

Edelweiss Applied Science and Technology
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Table 1.
Data collection techniques and tools.

Technical	Tools	Target
Observation	Observation grid	General neighborhood environment
		Household environment availability of sanitation works
Interview	Interview guide	Technical service manager of the town hall, SHAB (Basic Hygiene and Sanitation Service) manager of the DPS (Prefectural health directorate)
Household opinion survey	Quiz	Head of household/Representative
Laboratory analysis	Equipment materials consumables	Landfill waste (Fine fraction)

2.3.3. Household Survey

Study Population: The study population is made up of (i) the heads of the households surveyed or their representatives; (ii) The head of the technical sanitation service of the Vo1 municipality or representative; (iii) The head of the DPS hygiene and sanitation service or representative.

Sampling: The study covered all twenty (20) neighborhoods in the city. According to 2021 demographic data available at the Vogan polyclinic, the town's population is estimated at 15,983 inhabitants. The average size of households in urban areas is generally 4.2 people according to the results of the QUIBB survey carried out in Togo in 2015 [8, 9]. The number of households is therefore estimated at 3806 households (15983/4.2).

By setting a confidence threshold of 95%, i.e. a margin of error of 5%, the sample size (n) can be calculated as follows according to Robert Magnani's formula [13]:

$$n = \frac{\text{tp } 2 \times \text{P}(1 - \text{P}) \times \text{N}}{\text{tp } 2 \times \text{P}(1 - \text{P}) + (\text{N} - 1) \times \text{y2}}$$

n: Sample size.
p: Estimated proportion of the population that presents the characteristic (0.5 by default).
tp: Confidence level (the typical value of the 95% confidence level will be 1.96).
y: Margin of error set at 5%.
N: Number of households (N= 3806).
AN:

$$n = \frac{(1{,}96)\ 2 \times 0{,}5(1 - 0{,}5) \times 3806}{(1{,}96)\ 2 \times 0{,}5(1 - 0{,}5) + (3806 - 1) \times (0{,}05)2}$$

So, n = 349.02.

The sample size is therefore set at 350 households. The ratio 350/3806 (number of households surveyed to total number of households) or 9.196% is used to make the calculations according to the neighborhoods. The data for this distribution are recorded in Table 2.

Edelweiss Applied Science and Technology
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Table 2.
Distribution of the 350 households surveyed by neighborhood.

Order number	Name of neighborhoods	Population in 2021	Number of households	Number of households surveyed
1	Commander Condji	2,545	606	56
2	Adjrégo	850	202	19
3	Asiko	366	87	8
4	Kpota High School	645	154	14
5	Adoukome	288	69	6
6	Hlankome	255	61	6
7	Sagada	840	200	18
8	Agbemavo	1,540	367	34
9	Novissi	1,955	465	43
10	Mawulolo	425	101	9
11	Lissassikopé	1,248	297	27
12	Bame	695	165	15
13	Adanlekpodji	340	81	7
14	Doumakpoe	584	139	13
15	Amoindji	542	129	12
16	Totsoagni	280	67	6
17	Lomnava	1,205	287	26
18	Agbope	576	137	13
19	Atapé	358	85	8
20	Sopé	446	106	10
Total		15,983	3805	350

2.4. Inclusion Criteria

To be included in our survey, you must: (i) Be the head of household or their representative; (ii) Be 18 years old and over; (iii) Be from the locality (3 months of residence or more); (iv) Be present during the investigation; (v) Consent to respond to investigators.

2.5. Conduct of the Investigation

Interview: A first step in our study was to interview respectively the managers of the technical department of the town hall and the hygiene and sanitation department of the hospital.

Observation: In order to supplement the information obtained from the households and services surveyed, we observed and noted the state of waste management in the trafficked areas. These observations were direct and focused on the method of disposal of solid and liquid waste in the neighborhoods. During said observations, photographs were taken and attached to this document.

Household Survey: A total of 8 investigators (4 community relays from the health area and 4 individual agents) were recruited and trained on the administration of the questionnaire. Four (04) teams of 2 people were set up. Each team was led by a community relay. One household per concession was surveyed and, in each household, it was the head of household or his representative who was at least 18 years old who was surveyed. The choice of concessions was made by a random survey in the different neighborhoods. The sampling frame (number of households) of each neighborhood and the corresponding sample size are indicated in Table 2. The sampling interval is obtained by the ratio of the number of households to be surveyed to the sample size. The investigators used this step to move

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successively from one concession to another, allowing each team to cover almost the area entrusted to it. In the concessions, a semi-structured questionnaire was administered to a household. The first household from the right in each compound is surveyed. If the first household selected for the survey is absent, the next household is surveyed. In a concession to a single household, the latter is systematically retained.

2.6. Ethical Aspects

The administration of the School of Medical Assistants, the town hall of the Vo1 commune and the local DPS have issued us with authorizations in order to reassure the populations to be investigated. Verbal consent from the head of household is received before the questionnaire is admitted.

2.7. Laboratory Analyzes

2.7.1. Sample and Parameters Sought

Samples were taken from five (5) different dumpsites in the city. They are made from the fine fraction of waste (soil and/or ash) taken from the surface at various locations on each site (dump) then reconstituted into samples (one composite sample per site). The parameters taken into account when carrying out the analyzes were Cadmium (Cd), Lead (Pb), Copper (Cu), Chromium (Cr) and Zinc (Zn).

2.7.2. Sample Analysis Protocol [14, 15]

The solubilization method employed is acid mineralization using a hydrochloric and nitric acid mixture, following standard NF ISO 11466 (aqua regia method) for soils. The procedure takes place in a closed environment at 110-150°C. For each 1g sample, a 3:1 acid ratio (3ml of hydrochloric acid and 1ml of nitric acid) is required. After heating and acid digestion, the mixture is filtered. The filtrate, containing the elements to be measured, is analyzed using a spectrophotometer, with the final concentration (C) of trace elements calculated in mg/kg dry weight.

$$C\ (mg/kg) = \frac{\text{Concentration du spectromètre x volume de filtration}}{\text{Masse prélevée}}$$

The pollution factor (PF) of the sites analyzed is calculated as follows:

$$FP = \frac{\text{Concentration de l'élément chimique recherché dans le déchet}}{\text{Teneur limite de la référence}}$$

2.8. Data Analysis

The processing of the collected data was done manually. The data entered, clearance and processing were done with Epi info software version 7.2.2.6.

The number and proportion were used to present the results.

2.9. Constraints and Difficulties

During our research, we encountered several difficulties, notably those linked to the absence of data on waste management in the locality, the absence of actors operating in the field from whom to collect information and mistrust. and reluctance of some respondents to receive us, mainly due to lack of interest. Also, our program initially established for the collection of data in the field was quite disrupted by rains, thus extending the survey time.

3. Results

3.1. Socio-Demographic Characteristics

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 917-936, 2024
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Sex, level of study and religion: Table 3 shows the distribution of respondents according to sex, level of education and religion (n= 350). A total of 54% were male while 46% were female. Concerning the level of studies 29, 14% have reached cycle 2 of secondary school, 28.57% have completed at least primary school, 18.29% have cycle 1 of secondary school, 3.14% are university students and 20, 86% are out of school. The majority of respondents were Christians with a proportion of 55.43%. Animists and practitioners of Islam represent a proportion of 28.86% and 8.28% respectively. Other religions combined accounted for 7.43%.

Table 3.
Distribution of respondents according to gender, educational level and religion.

Variables	Descriptions	Effective	Proportion
Sex	Male	189	54.00
	Feminine	161	46.00
Level of study	Unschooled	73	20.86
	Primary	100	28.57
	Secondary cycle1	102	29.14
	Secondary cycle 2	64	18.29
	University	11	3.14
Religion	Animism	101	28.86
	Christianity	194	55.43
	Islam	29	8.28
	Other	26	7.43

Age of respondents and size of households: The age of respondents was 18 to 82 years with an average age of 45.43±12.42 years. The most represented age was 38 years old. The average size of the households surveyed was 5.2±2.14 people per household. Most households had 4 people and the largest household had 12 people.

Type of housing and housing occupancy status: Table 4 provides us with information on the distribution of respondents according to the type of housing they occupy and their occupation status (n= 350). Of the 350 surveyed, 285 (81.43%) have medium-standard housing. Traditional and high-end housing occupied 12.57% and 6% respectively. The data on housing occupancy status showed that 43.14% of homes are personal properties, 32.57% of respondents are tenants and 24.29% of homes are family properties.

Table 4.
Distribution of households according to type of housing and occupancy status.

Variables	Descriptions	Effective	Proportion
Type of habitat	High standard	21	6.00
	Average standing	285	81.43
	Traditional	44	12.57
Habitat occupancy status	Personal property	151	43.14
	Family property	85	24.29
	Tenant	114	32.57

Profession of respondents: Table 5 indicates the distribution of heads of households met during our survey according to their main profession (n=350). The majority of respondents were traders in a proportion of 29.43%. Artisans and employees represent 18 and 18.57% of respondents respectively.

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ISSN: 2576-8484
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Farmers, housewives, motorcycle taxi drivers and student apprentices represent 14%, 11.72%, 7, 14% and 1.14% respectively.

Table 5.
Distribution of our respondents according to profession.

Occupation	Effective	Proportion
Employee	65	18.57
Trader	103	29.43
Artisan	63	18.00
Farmer	49	14.00
Motorcycle driver/Taxi	25	7.14
Household	41	11.72
Student/Apprentice	4	1.14
Total	350	100.00

3.2. Description of the Existing Waste Management System

3.2.1. Household Waste Management

Existence of bins and waste sorting: The majority of households had bins for their waste. Of the 350 households surveyed, 51 (14.57%) did not have trash cans compared to 299 (85.43%) who did. Compared to sorting at source, only 5 households out of 350 practiced it, i.e., a proportion of 1.43%.

Discharge of trash cans: Figure 2 shows the distribution of households according to the frequency of discharge of their trash cans. Those who are quite far from landfills often tend to keep waste at home for a long time. 5.35% of respondents keep their trash cans for more than a week, 12.04% empty their trash cans once a week, 51.17% empty their trash cans two to three times a week and 31.44% empty them every week.

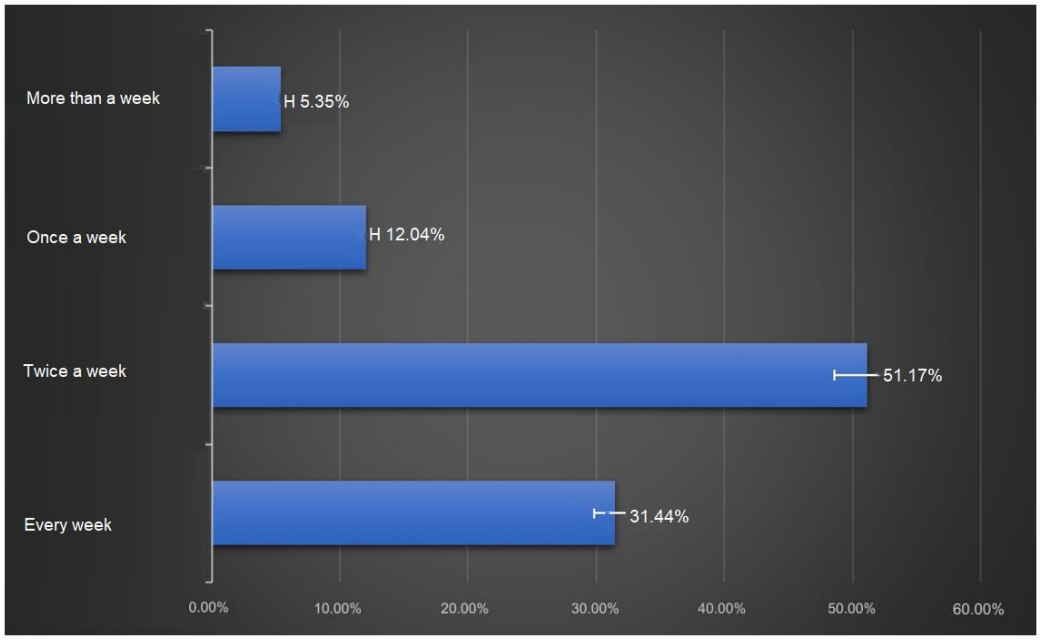

Figure 2.
Distribution of households according to the frequency of discharging their trash cans.

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ISSN: 2576-8484
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Existence of a pre-collection service and developed dump sites: There was no structure responsible for pre-collection according to all 350 households surveyed. Likewise, no dump in the locality was set up to accommodate household waste.

Waste disposal location: Figure 3 shows the distribution of respondents according to their waste disposal locations. Of the 350 surveyed, 282 dispose of waste in illegal dumps, 92 in the fields and 37 in the street.

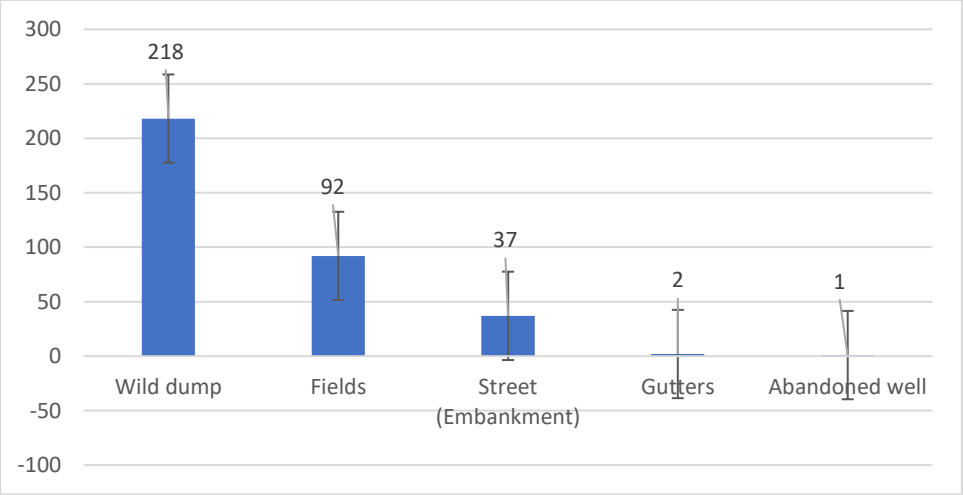

Figure 3.
Distribution of households according to the place of disposal of their waste.

The figure represents a bar chart that displays the distribution of a certain variable across different types of locations.

Waste disposal method: **Figure 4** gives the distribution of respondents according to the treatment they give to their waste. Sixty-eight percent (68%) of respondents do not treat waste before disposal. Burning and burying are used by 27.59% and 4.14% of respondents respectively.

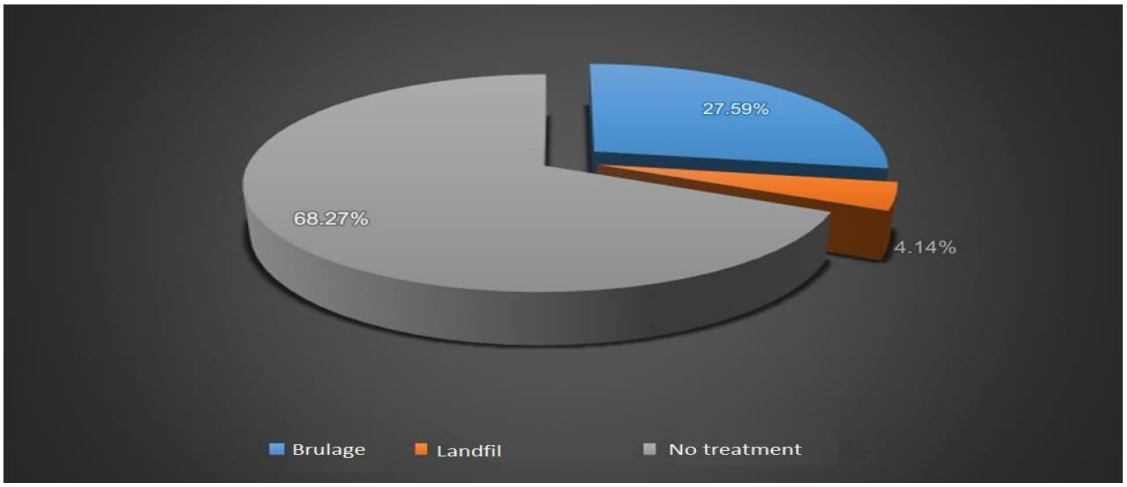

Figure 4.
Distribution of households according to the method of managing their waste.

Edelweiss Applied Science and Technology
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Vol. 8, No. 6: 917-936, 2024
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Acceptance of a pre-collection service: Table 6 shows the distribution of respondents according to whether or not they accept the idea of a pre-collection service to help them remove waste from their households. Thus 81.14% accepted the help of a pre-collection service while 18.86% refused.

Table 6.
Distribution of respondents according to the need for a pre-collection service.

Need pre-collection service	Effective	Proportion
Yes	284	81.14
No	66	18.86
Total	350	100.00

Ability to pay for a pre-collection service: Figure 5 shows us the ability of households to pay for a pre-collection service, based on a monthly subscription of 500 F or 1000 F or 1500 FCFA. (n =284). Of the 81.14% who accepted the help of a pre-collection service, 60.69% declared having the capacity to pay 500 F, 37.20% were able to pay 1000 F and 2.11% 1500 F.

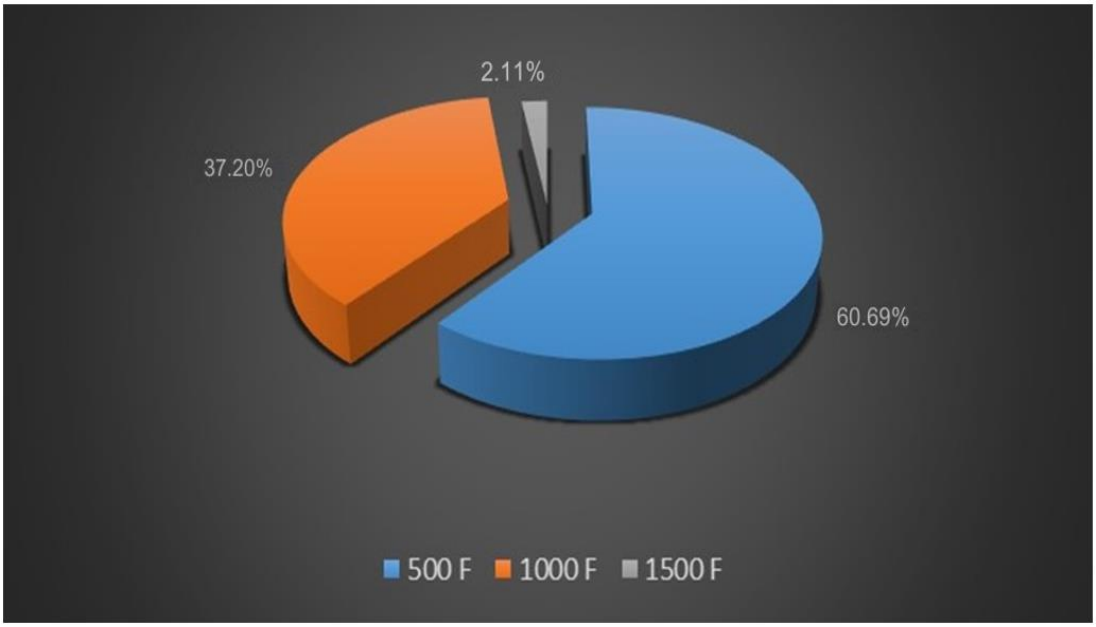

Figure 5.
Distribution of households according to their ability to pay for a pre-collection structure.

The image shows a pie chart displaying the distribution of three categories represented by different amounts in "F" (likely currency): 500 F, represented by the blue segment, taking up 60.69% of the total; 1000 F, represented by the orange segment, accounting for 37.20%; 1500 F, represented by the gray sliver, contributing to 2.11%.

3.3. Assessment of the Population's Level of Knowledge in Waste Management

3.3.1. Hear About Waste Management and Recovery

Figure 6 provides information on the distribution of respondents according to their knowledge of waste management and recycling. Waste management and recycling are known by 62.29% and 46%

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ISSN: 2576-8484
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respectively. However, 37.71% and 54% declared that they had no knowledge of waste management and recycling.

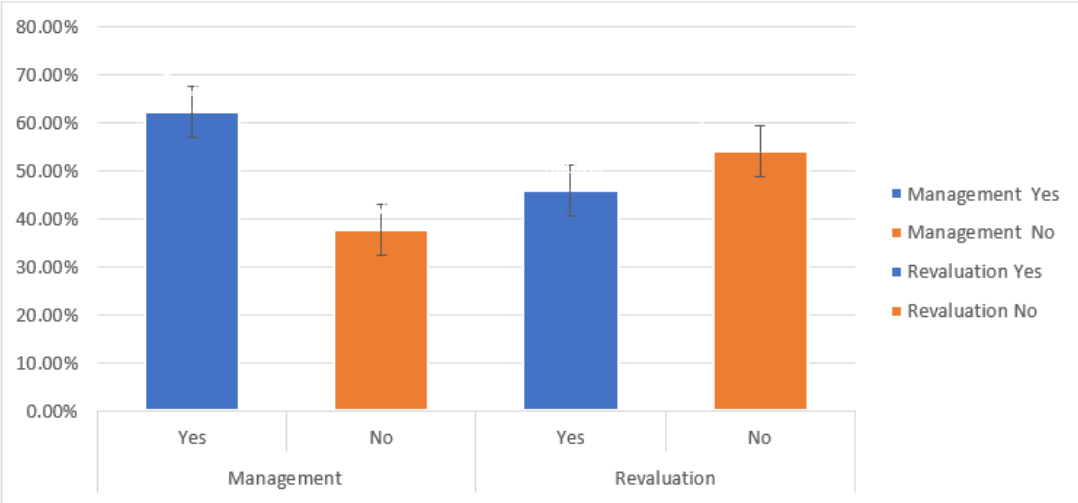

Figure 6.
Distribution of respondents according to their knowledge of waste management and recovery.

The figure 6 shows a bar chart comparing the proportions of responses (labeled as "Yes" and "No") across two categories: Management and Revaluation. Each category has two bars, one for "Yes" and another for "No", represented in blue and orange, respectively.

3.3.2. Information Channel

Table 7 shows the distribution of our respondents according to their sources of information regarding waste management. These can be radio broadcasts, awareness sessions, home visits, etc. Fifty (50) % are informed about waste management via the media (radio), 24.31% by health workers, 16 .51% by NGOs and 9.18% by town hall agents.

Table 7.
Distribution of respondents according to information channel.

Information channel	Effective	Proportion
Town hall agents	20	9.18
Health workers	53	24.31
Media (radio)	109	50.00
NGOs	36	16.51
Total	218	100.00

3.3.3. Risks Posed by Waste

Figure 7 shows the distribution of respondents according to their knowledge of the risks that waste can present to the population and the environment. Waste is considered a source of germs and diseases for 99.43% of respondents. 86.86%, 13.71% and 3.14% respectively consider waste as sources of bad odors and air pollution, deterioration of the quality of drinking water and as a source of destruction of aquatic living beings. Among the respondents, 0.57%, 13.14 %, 86.29% and 3.14% think that waste is not a source of microbes and diseases, nor of bad odors and air pollution, nor of the deterioration of the quality of drinking water and nor as a source of the destruction of aquatic living beings.

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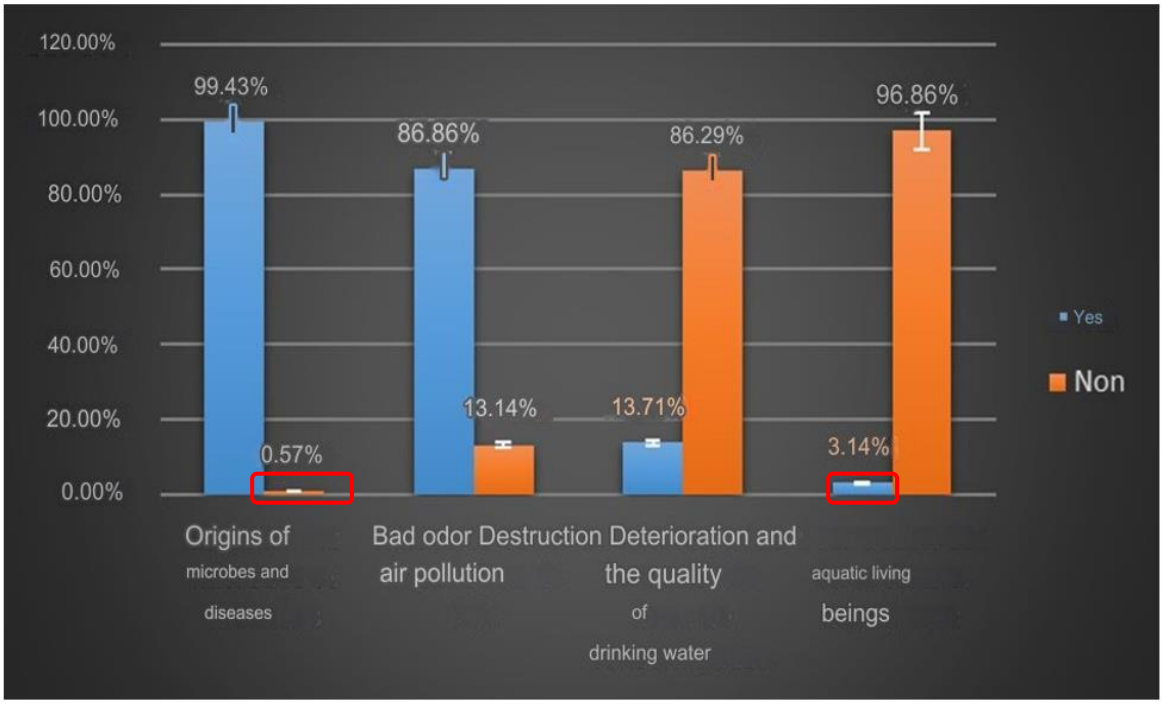

Figure 7.
Distribution of respondents according to their knowledge of waste-related risks.

3.3.4. Best Ways of Waste Disposal

Figure 8 distributes households according to the best management to give to waste according to their knowledge. The majority of respondents (70%) think that implementing a pre-collection structure is the best way to eliminate waste. A proportion of 20% think that burning is the best method of waste management while 10% recommend burying waste.

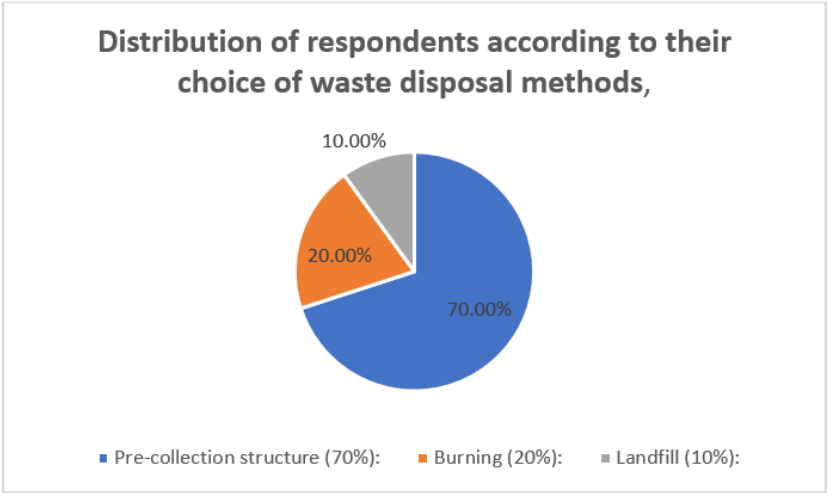

Figure 8.
Distribution of respondents according to choose of waste disposal methods.

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The majority of respondents (70%) use a pre-collection structure for waste disposal. This could involve systems in place before formal waste collection, like community bins or local collection points. A smaller portion of respondents (20%) dispose of waste by burning it. This method is common in areas where formal waste collection is lacking but poses environmental and health risks. The smallest group (10%) chooses landfill disposal. This method, while more organized, may indicate that only a limited number of respondents have access to formal landfill facilities.

From our observation, the problem of solid household waste in the town of Vogan is an undeniable reality which requires in-depth reflection. Figures 9 to 14 present the actual state of the issue in the locality. Illegal dumpsites (Figure 10 and 11), a blocked public road and gutters clogged with waste (Figure 12), wastewater dumped on public roads are illustrated.

Figure 9.
Some examples of household trash cans.

Figure 10.
Some illegal dumpsites.

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Figure 11.
Wild dumps opposite and behind the big market.

Figure 12.
Public road blocked and gutters clogged with waste.

Figure 13.
Dumping of wastewater and waste on public roads.

Edelweiss Applied Science and Technology
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Figure 14.
Recyclable waste sales site.

3.4. Laboratory Analysis Results

3.4.1. Contact Details of Sampling Sites

Table 8 presents the geographic coordinates of the different sites where the samples were taken. Each sampling site corresponds to a composite sample.

Table 8.
Sampling sites and corresponding geographic coordinates.

Sites (Samples)	Latitude	Longitude	Position code
Site 1 (E1)	6.34	1.53	6FR38GQF+VV
Site 2 (E2)	6.33	1.53	6FR38GHH+M4
Site 3 (E3)	6.34	1.52	6FR38GQC+QW
Site 4 (E4)	6.34	1.52	6FR38GRF+CG
Site 5 (E5)	6.34	1.52	6FR38GPF+M3

6FR3: The area code, which covers a large geographical region (usually about 100 km²). 8GQF, 8GHH, 8GQC, 8GRF, 8GPF: The local code, which pinpoints a more specific location within the area code (usually down to a few meters). +VV, +M4, +QW, +CG, +M3: An additional code that helps to further refine the exact location within the local code.

3.4.2. Concentrations of Chemical Elements

Table 9 presents the concentrations of the different chemical elements (metals) measured in soil samples from the city's illegal dumps. These elements are found on all the sites analyzed. The values found are compared with the tolerance limit values for residences and parks from the Canadian Council of Ministers of the Environment. Zinc is found in proportions that exceed recommended standards on all sites. Site 4 is the most polluted site with chemical elements such as cadmium (10.73 mg/kg), lead (304.54 mg/kg), copper (686.00 mg/kg) and zinc (775.95 mg/kg) whose dosage reveals concentrations well above standards. Sites 1, 2, 3 and 5 with the exception of the zinc content recorded tolerable levels of cadmium, lead, chromium and copper.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 917-936, 2024
DOI: 10.55214/25768484.v8i6.2186

Table 9.
Results of chemical element determination.

Metallic elements (mg/kg)	Samples					CCME 2021 standards*
	E1	E2	E3	E4	E5	
CD	0.21	0.61	0.40	10.73	0.58	10
Pb	40.49	58.59	27.37	304.54	115.17	140
Cr	17.40	17.18	12.15	21.44	49.95	64
Cu	25.56	43.82	11.46	686.00	59.71	63
Zn	711.95	727.19	661.55	775.95	1082.63	250

Note: *Indicates that the values under the CCME 2021 standards column refer to the maximum permissible concentrations (mg/kg) of the respective metallic elements in soils or sediments as outlined by the Canadian Council of Ministers of the Environment (CCME) Soil Quality Guidelines 2021.

3.4.3. Pollution Factor of the Chemical Elements Measured

Table 10 shows the pollution factors (PF) of trace metal elements (TME). These factors reflect the degree of pollution of the sites analyzed with regard to the chemical elements sought. The higher the content of an element, the higher its pollution factor and also the higher the risk of exposure. With the exception of the copper pollution factor at site 4 (10.888), the zinc pollution factor is the highest at all sites and site 4 recorded the highest pollution factors with the exception of zinc pollution factor (4.330) at site 5.

Table 10.
Calculation of pollution factors for chemical elements.

AND M	FP1	FP2	FP3	FP4	FP5
CD	0.021	0.061	0.040	1,073	0.058
Pb	0.289	0.418	0.195	2,175	0.822
Cr	0.271	0.268	0.189	0.335	0.780
Cu	0.405	0.695	0.181	10,888	0.947
Zn	2,847	2,908	2,646	3,103	4,330

4. Discussion

4.1. Discussion of the Methodology

In our study, the household survey was conducted randomly and included all socio-professional and religious groups, without discrimination based on living standards, as it covered various types of housing. This approach ensures that the results reflect the practices and habits of the majority of households and accurately represent the everyday experiences of the entire population of the city. These findings can serve as a useful tool for decision-making aimed at improving the living conditions of citizens. However, our study only covered 350 out of nearly 4,000 households in the locality. A larger sample size would yield more reliable and precise data. Additionally, while the survey targeted household heads, we often had to interview men present at the time, even though women, who manage most household activities, should have provided the answers. Redefining the criteria for selecting respondents in future studies could help distinguish between the respondents, who are predominantly women, and the official heads of households, who are often men [2].

4.2. Socio-Demographic Characteristics

Our survey involved 350 heads of household from the 20 neighborhoods of Vogan. The results revealed that 54.00% of the respondents were men and 46.00% were women, acting as household heads or representatives. The surveyed individuals, with an average age of 45.43 years and ages ranging from 18 to 82, largely had at least a basic level of education, with 47.43% having completed secondary

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 917-936, 2024
DOI: 10.55214/25768484.v8i6.2186

education and 3.14% having pursued higher education. However, 20.86% of the respondents had never attended school. Similar studies, such as Titone [16] in Agou1 in 2020 and Tchakou in Vo3 in 2021, reported comparable average ages of 47.75 and 45 years, respectively, among respondents with secondary education. [**2**, **17**]. Similarly, Guidi reported 18.72% of out-of-school individuals among the households surveyed in Adétikope in 2020 [**18**]. According to our findings, commerce was the most common activity in the study area. This was also observed by Guidi and Titone in their 2020 studies in Agoé Nyivé 6 and Agou Gadzépé, respectively [**16**, **18**]. More than four out of five households surveyed (81.43%) lived in medium-standard concessions, reflecting the relatively average standard of living in the population. Traditional concessions were estimated at 12.57% [**16**, **18**]. Among the households surveyed in these concessions, 43.14% were owners, 32.57% were family members, and 24.29% were tenants, according to our results. The average number of people per household was 5.2; four (4) people per household being the most represented in our series. According to the QUIBB [8] survey, the average household size in Togo was 4.7 in general and in particular 4.1 in urban areas and 5.3 in rural areas [**8**].

4.3. Existing Household Waste Management System

In our work, 85.43% of households had bins for packaging their household waste before their disposal. Among them, only 1.43% sorted waste for use in improving fields. According to them, this sorting consisted in particular of getting rid of the waste, mainly made from livestock droppings, from the plastic bags they contained. However, many previous works have found results significantly lower than ours. Thus, in 2020 Titone [16] showed that only 46.40% of households in Agou Gadzépé had trash cans in their households; Kpizou and Tchakou had respectively found 56.97% in 2021 in Adétikopé and 58% in 2022 in the Vo3 commune in 2022 [**3,** 19]. The difference observed in our study could be due to the fact that more than half of our respondents kept waste for two or three days at home before disposing of it. Indeed, according to our results, a little more than one in two households (51.17%) unloaded their trash cans twice a week, 12.04% once a week and only 31.44% emptied their trash cans. on a daily basis. The absence of a pre-collection structure responsible for the removal of household waste and that of developed dumpsites, encountered in our study, as noted by Attisso, Titone and Tchakou respectively in Bassar in 2015, in Agou Gadzépé in 2020 and in Vo3 in 2022, would be at the origin of the birth and multiplication of illegal dumpsites in the city and its surroundings [16**,** 17**,** 20]. This is how nearly two thirds of respondents (62.29%) claimed to use these illegal dumpsites for the disposal of their waste, while more than one person in ten (10.57%) used the streets. as dumping sites and 0.57% the gutters with the consequences of unsanitary neighborhoods, bad odors, the proliferation of disease vectors and pathogenic germs, the degradation of public roads and the blockage of gutters accompanied by flooding. Also, 27.59% of our respondents burned their garbage in the open in front of their compound or on undeveloped land and 4.14% buried it. These practices, respectively sources of atmospheric pollution with exposure to lung diseases and percolation of groundwater with pollution of groundwater, have also been reported by a number of similar studies. This is the case, for example, of the commune of Agou1 described in 2020 by Titone [16] where 3.15% of households surveyed buried their waste in the ground, a result close to what is experienced in the town of Vogan. Similarly, the burning of garbage in small piles next to concessions throughout the city was also described by Tchakou [17] in the Vo3 commune. Faced with these problems, there is an urgent need to adopt better household waste management practices, which necessarily involves a pre-collection service. The majority of households surveyed (81.14%) agreed to subscribe to a pre-collection structure. Among them, only 37.20% agreed to pay 1000 francs per month and 60.69% 500 francs per month.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 917-936, 2024
DOI: 10.55214/25768484.v8i6.2186

4.4. Notions on Waste Management

More than three out of five respondents (62.29%) claimed to have heard at least once about waste management, the majority of which through local radio stations (50.00%) and health workers (24.31%). However, the notions of waste recovery are not mastered by everyone (46.00%). Aware of the danger represented by poor waste management, the majority (70.00%) of them considered that the service of a waste removal structure from households for a developed dump would be the best management method. However, 20.00% of the population studied supported the open burning of household waste and 10.00% their burying in the ground, the latter citing insufficient financial means to support the cost of pre-collection. Burning and burying are respectively the origin of atmospheric pollution and groundwater, it will then be necessary to intensify awareness raising within the community to get the entire population to adhere to the idea of collecting and removing waste. waste by an appropriate structure.

4.5. Laboratory Results

Trace elements are chemical elements naturally present at minimal concentrations in soils, rocks and living organisms. Some are trace elements (Zinc) but others such as lead and cadmium are toxic whatever their concentration. According to our results, the five chemical elements sought are found on the five sites where the samples were taken but at varying concentrations. All 5 dumpsites analyzed are polluted by Zinc with very high concentrations (from 661.55 for site 3 to 1082.63 mg/kg for site 5). The same observation was made by Bodjona et al. on the site of the former Agoè landfill where Zn was found at very high levels in the soil [21]. The site most at risk with regard to the elements sought in our study is 4 which, in addition to Zn, also has a high content of Cd, Pb and Cu. The level of this risk is reflected in the high values of the pollution factors of some of the elements measured (Cd at 1.073, Pb at 2.175, Cu at 10.888 and Zn at 3.103). The presence of these elements on the landfills studied would be due to the heterogeneity of the waste dumped or burned there. According to Bouchaakor and Malayeri cited by Bodjona , "waste electrical and electronic equipment, tires, plastic materials and medical waste present in illegal dumps of household waste can be sources of high concentrations of heavy metals in the soil. » [**21**]. Wild and uncontrolled dumpsites therefore constitute a problem for the environment. The accumulation of these heavy metals on these sites is a potential risk for living beings. They can contaminate groundwater and surrounding crops. Sorting waste at source accompanied by specific treatments for each type of waste would make it possible to considerably reduce the pollution caused by these chemical elements.

5. Solution Approaches

At the end of this work and given the results obtained with regard to the inadequacies observed in the city, it is appropriate to formulate recommendations. At the Vo 1 town hall: Recruit a sanitation hygiene technician, reorganize the sanitation sector with emphasis on the role of each actor (households, the municipality, NGOs and associations, partners, …) set up a waste pre-collection structure, set up a public dump far from the city, encourage waste recovery initiatives in the municipality, decree a public health day in the city, intensify public awareness on the responsibility that falls to them in the effective management of household waste and the like and if possible put in place dissuasive measures in the face of non-compliance with the decisions taken, popularize and enforce the laws governing sanitation in the Togolese Republic, accelerate the process to the construction of the Technical Landfill Center . With regard to the Basic Hygiene and Sanitation Service of the Prefectural Health Directorate, it will be necessary to continue collaboration with the city authorities in the management of sanitation and to intensify public awareness on solid waste management.

For households: Observe the decisions taken by municipal and health authorities for healthy waste management in the locality; Adopt responsible sustainable consumption and production patterns; Sorting waste at the source of production and subscription to pre-collection structures.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 917-936, 2024
DOI: 10.55214/25768484.v8i6.2186

6. Conclusion

Our work aimed to take stock of household waste management in the town of Vogan. It allowed us not only to depict and analyze the situation which currently prevails in this city with regard to the attention given to the management of household and similar waste, but also to take a look at the availability of waste management works. sanitation and the level of knowledge of the populations. The portrait of the daily experiences of households through our survey reveals the difficulties and inadequacies leading to poor waste management. Indeed, the management of solid waste in the environment is characterized by the absence of a pre-collection structure and developed dumpsites, leaving the population on their own. These problems have given rise to practices which are completely out of step with the standards. recognized specific requirements in terms of sanitation and public health and which deserve particular attention. This is how our field observations highlighted a multitude of illegal dumpsites around the city, burning piles of waste in front of houses, and the use of waste to fill the streets. Added to these problems is the lack of awareness by the majority of the population of the real dangers posed by these practices and the risks involved, in particular pollution of the living environment, contamination of groundwater, respiratory diseases, diseases linked to faecal danger. The multiplication of disease-carrying insects. At the end of our study, we were able to highlight the city's problems relating to waste management as well as the resulting consequences. An effective awareness of all stakeholders with actions such as intensifying awareness and setting up sanitation works will not only clean up the environment and provide an attractive shine to the city but also and above all to guarantee good health to the population.

Institutional Review Board Statement:
The Ethical Committee of the [EAM/ University of Lomé], Togo has granted approval for this study on DATE May 2022 (Ref. No. N° 0383/22/EAM/UL/05-2022).

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Edelweiss Applied Science and Technology
ISSN: 2576-8484
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