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Household solid waste management in Grand-Lahou on the south-west coast of Côte d'Ivoire

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Abstract

Poor management of household solid waste has a negative impact on the environment and can be a source of many illnesses. In order to improving the living environment of local populations, this study aims to analyze household waste management in of Grand-Lahou. Data were collected through field observations, a survey and a characterization of the waste produced in the households. The respondents were all over 25 years of age, with a higher proportion of women (65%). The waste produced in Grand-Lahou households is packaged in makeshift garbage cans (garbage can liners (9.5%), used buckets (30.9%), old basins (4.8%), cut cans (16.7%) and old bags (38.5%). Pre-collection and collection of this waste is essentially handled by the Technical Department of Grand-Lahou municipality, which covers only 60% of the town. The waste collected is dumped at the town's municipal landfill. However, more than half of households (59%) sort a few items, such as banana and manioc peelings, used rubber shoes, buckets, used rubber containers, iron and aluminum items (used appliances and fans, cans, etc.), which are directed towards recycling channels. Concerning the composition of the waste, it is dominated by putrescible materials (42.05%) and plastics (20.25%), suggesting that the waste could be recovered and recycled.

Keywords: Household waste; Characterization; Management; Grand-Lahou; Côte d'Ivoire

1. Introduction

Developing countries face many challenges, including the preservation of the environment and public health. Conferences from Stockholm to Rio 1992 have focused on measures to preserve the environment in order to achieve sustainable development. Sustainable waste management in cities is thus becoming a major issue, as it contributes positively to maintaining ecology and preserving public health [1].

In the majority of cities in developing countries, particularly in Sub-Saharan Africa, solid waste management poses enormous difficulties and runs counter to certain principles of ecological prudence and sustainable development [2,3]. Indeed, the cities of these countries have been facing galloping urbanization for several decades. This densification of cities is accompanied in particular by a significant increase in waste production, while the infrastructure and social services required for healthy urban living are not evolving at the same pace [4,5]. According to the World Bank [6], more than half the world's population has no access to a household waste disposal service, and around 4 billion people use illegal or unregulated landfills, which accommodate more than 40% of the garbage produced worldwide.

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The situation is particularly serious in African cities, where high population densities and changing living standards lead to concentrations of waste that make it even more difficult to deal with [7]. This situation negatively affects the quality of the environment, the living environment and the health of populations through so-called environmental diseases such as diarrhea, malaria, cholera and typhoid fever [8-10].

Côte d'Ivoire is not on the sidelines of this situation, which is why the Ivorian public authorities, through the National Development Plan, have indicated the impact of waste on human health. To remedy this situation, they have made improving people's living environments a priority. This led to the creation in 2017 of the ANAGED (Agence Nationale de la Gestion des Déchets), which coordinates the household waste management system at national level. Since its creation, ANAGED has undertaken the modernization of the sector through major actions (recruitment of companies to delegate the public cleanliness service, construction of a landfill and recycling center, waste transfer station, grouping stations, etc.) whose beneficial effects on the living environment are perceptible [11].

However, ANAGED's actions are focused on the country's major conurbations (Abidjan, Man, Bouaké, Korhogo, San-Pédro, Dabou, Grand Bassam, Bondoukou, Daloa, Gagnoa and Yamoussoukro), to the detriment of other towns such as Grand lahou, which is experiencing difficulties in managing solid household waste. However, the town of Grand-Lahou benefits from the meeting of three bodies of water (the Bandama river, the Tagba lagoon and the Atlantic Ocean), which gives it a large number of tourist attractions. To boost tourism in the town and to improve the living conditions of local populations, this study aims to analyze household waste management in the town of Grand Lahou.

2. Material and method

2.1. Study area

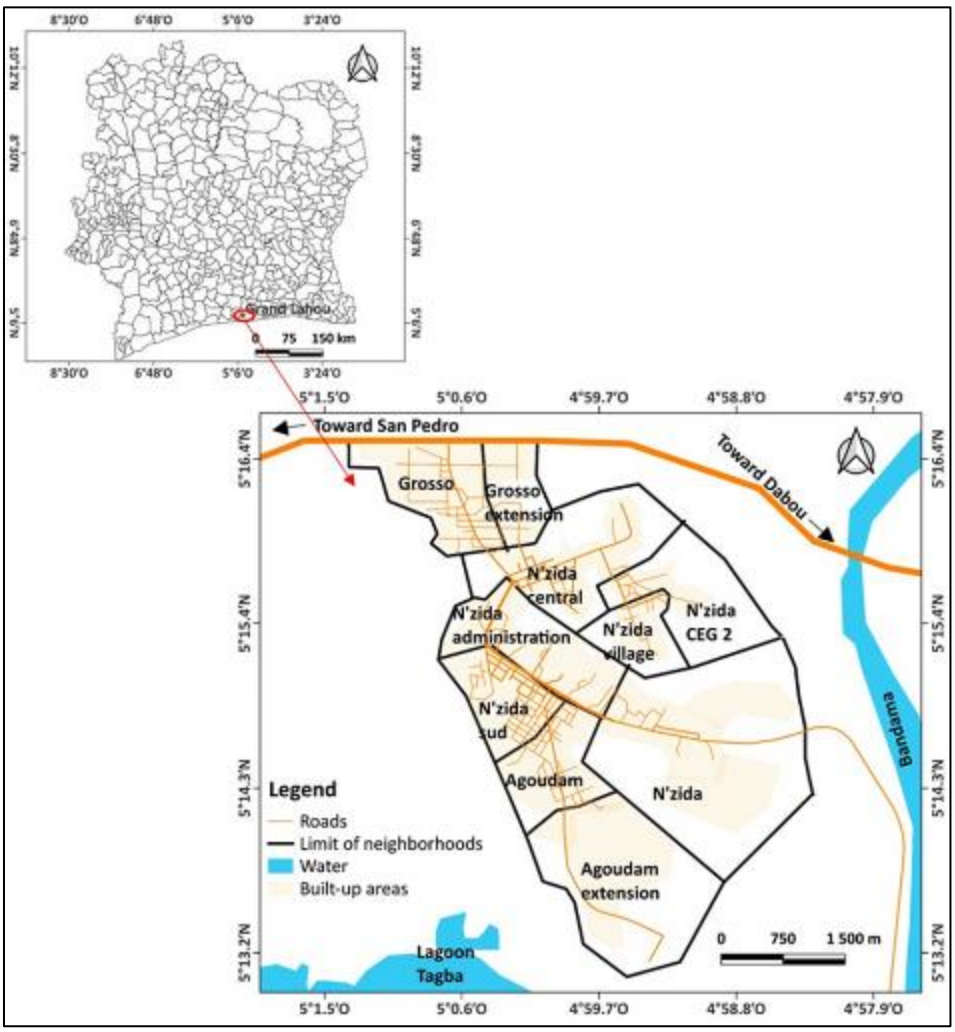

Figure 1 Location of the town of Grand-Lahou

Located in the West African sedimentary basin, 149 kilometers from the Ivorian economic capital, Abidjan, Grand-Lahou lies between latitudes 5°12'N and 5°9'N and longitudes 4°56W and 5°70W. Almost at the center of Côte d'Ivoire's coastline, the town is a peninsula located at the mouth of the Bandama River, between the lagoon complex and the Atlantic Ocean. The town of Grand Lahou comprises 10 neighborhoods: N'zida CEG 2, N'zida central, N'zida village, N'zida, Agoudan, Agoudan extension, N'zida administrative, Grosso, N'zida south and Grosso extension (Figure 1).

2.2. Data collection

Data collection was carried out in September 2021 and consisted of field observations, a survey and waste characterization. Field observation involved visiting Grand-Lahou neighborhoods (N'zida CEG 2, N'zida central, N'zida village, N'zida, Agoudan, Agoudan extension, N'zida administrative, Grosso, N'zida south, Grosso extension) with the aim of knowing solid waste management pratices. During the visit, photographs were taken to illustrate the situations observed. As for the survey, it consisted in administering the form drawn up for this purpose to every adult encountered in the households to gather information on the pre-collection, collection and disposal of solid waste at households. The sample size was determined using data from the 2014 general population and housing census produced by the INS (Institut National de la Statistique). The following formula from Grumuchian and Marois [12] was used to determine the representative sample (1) :

$$n = \frac{Z^2(PQ)N}{((e^2(\mathrm{N}-1) + Z^2(PQ)} \quad \ldots\ldots\ldots \ (1)$$

where:
n : Size of sample to be surveyed ;
N : Size of the parent population ;
Z : Margin coefficient (determined from the confidence level)
e : Margin of error ;
P: Proportion of households assumed to have the desired characteristics. This proportion, varying between 0.0 and 1, is the probability of occurrence of an event. In the case where no value is available for this proportion. It is set at 50% (0.05)

$$Q = 1\text{-}P$$

Assuming N=31,663, P= 0.5 and Q= 0.5; at a confidence level of 95%, Z=1.96 and margin of error e= 0.05, the minimum representative household size is estimated at 369.

Concerning solid waste characterization, it was carried out using the MODECOM method [13], which involved quantifying the fractions (putrescibles, paper, cardboard, composite packaging, textiles, plastics, unclassified fuels, glass, metals, unclassified incombustibles, hazardous waste and fine elements) of solid waste. For this purpose, 100 L garbage can liners were placed in the various households surveyed. These bags were collected within 48 hours, i.e. two days later. The waste from the same types of habitat was then mixed. After quartering 500 kg of waste, 120 kg was sorted and separated. Each of the separated fractions was weighed.

2.3. Data analysis

The data collected from the survey form were coded and then grouped into categories. The relative frequencies of each variable were calculated in relation to the number of households surveyed, using formula (2) :

$$\mathrm{F} = \frac{\mathrm{X}}{\mathrm{Y}} \times 100 \quad \ldots\ldots\ldots\ldots (2)$$

With :
F: Frequency (%);
X: Number of modalities;
Y: Total number of respondents.

The composition of household waste was determined according to the following relationship (3):

$$\mathrm{P_i} = \frac{\mathrm{M_i}}{\mathrm{M_t}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Pi : Proportion of a waste category (%) ;
M: Mass of a waste category (Kg);
M : Total mass of waste (Kg).

3. Results and discussion

3.1. Socio-demographic characteristics of households surveyed

The people surveyed in this study were all over 25 years of age, with a higher proportion of women (65%). These women, most of whom were housewives (52.5%), were said to be housekeepers in the absence of their spouses, who would leave early to join their business activities. With regard to the respondents' level of education, 8% had completed higher education, 23.1% had secondary education, 23.1% had primary education and 27.1% had never attended school (Table 1).

Table 1 Socio-demographic characteristics of surveyed households

Socio-demographic characteristics		**Percent (%)**
Gender	Male	35
	Female	65
Age	25-50 ans	58.6
	50-70 ans	35.7
	< 70 ans	5.7
Education level	No formal education	27.1
	Primary school education	23.1
	Secondary school education	41.8
	High school education	8
Profession of head households	Self-employment	22.3
	Employees and workers	17.9
	housewives	52.7
	Retired workers	5
	Unemployed	2.1

3.2. Household waste management practices

3.2.1. Waste packaging

Figure 2 Overview of some household waste storage facilities in the town of Grand Lahou; A= Old buckets and cut cans; B= Old bags

Waste is packaged in makeshift garbage cans at household level (Figure 2). These makeshift garbage cans are used by 9.5% of households for garbage can liners, 30.9% for used buckets, 4.8% for old bowls, 16.3% for cut cans and 38.5% for old bags (Figure 3). Studies carried out in Liberia [14], Ghana [15], Nigeria [16] and Uganda [17] report a similar means of storage. This can be explained either by the fact that most households experience household financial difficulties in appropriating conventional garbage cans even though they are environmentally [16,18].

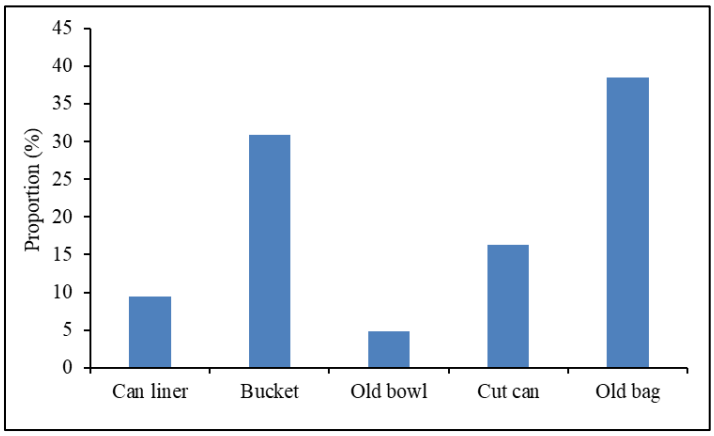

Figure 3 Household waste storage facilities in the town of Grand Lahou

3.2.2. Waste pre-collection and collection

Pre-collection and collection of waste is essentially handled by the Technical Department of Grand-Lahou municipality, which covers only 60% of the town. This waste collection is only carried out in the town center, especially around the market, where there are no garbage bins. Collection frequency is once (1) a week or once (1) every two (2) weeks. In addition, the municipality has very little equipment to ensure both pre-collection and collection of waste. These consist of two (2) 3- to 4-ton tractors, one (1) of which was non-functional during the study period, and one (1) 1.5-ton tricycle (Figure 4). The staff assigned to pre-collection and collection of waste consisted of 25 people.

Figure 4 Waste pre-collection and collection equipment in Grand-Lahou; A = functional tractor; B = non-functional tractor; C = functional tricycle

All households surveyed (100%) are not satisfied with the current pre-collection and collection of their waste. Some households use private individuals to collect their waste two (2) to three (3) times a week for a fee ranging from 500 to 2,000 F CFA per month. Other households, on the other hand, dump their own waste in gutters, ravines and nearby unused land (illegal dumps), or burn it in the open air (Figure 5). This situation makes the town of Grand-Lahou very unhealthy for 62% of households surveyed (Figure 6). The proliferation of uncontrolled dumping points is a potential source of so-called environmental diseases, including diarrhea, malaria and acute respiratory infection (ARI) [8-10]. Furthermore, smoke from waste burning contains carbon monoxide, soot, ash, bitumen and numerous pollutants, some of which are known carcinogens [19].

Figure 5 Household waste dumping in the N'zida Sud (A), N'zida (B) and Grosso (C and D) districts of Grand-Lahou

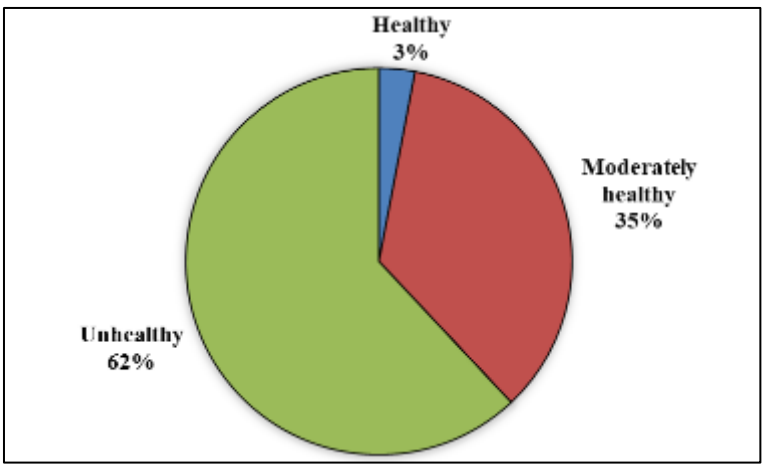

Figure 6 Respondents' assessment of the state of sanitation in Grand Lahou

3.2.3. Waste sorting and recovery

Figure 7 shows the proportion of households practicing waste sorting. It shows that more than half of households (59%) sort a few items from the waste they produce before putting them in the garbage cans. Waste sorting helps to save natural resources, avoid waste and limit pollution. The objects recovered in the town of Grand-Lahou and their uses are presented in table 2.

Table 2 Waste recovered by households and its uses

Recovered waste	**Use of recovered waste**
Banana and manioc peelings	- Domestic animal feed - Potash production
Used rubber shoes	- Sales to recovery agents
Used buckets, cans and rubber containers, plastic bags	- Sales to recovery agents
Iron and aluminium objects (used appliances and fans, cans, etc.)	- Sales to recovery agents
Unused cans and bottles	- Reuse to conserve water and juices
Palm seed residues	- Fuel for cooking food

During field visits, three (3) waste recovery and recycling operators were identified, including two (2) in the Grosso district and one (1) in the N'zida neighborhood. These players collect and buy items such as scrap metal (used vehicle bodies and parts, used household appliances, etc.), aluminum (tin cans, used cooking pots, old sheet metal, etc.), and rubber (buckets, cans, used rubber shoes and containers, plastic bags, etc.). This waste is transported to Abidjan in 10-wheel lorries (one lorry load per six months), where it is sold to companies that recycle this type of waste. Figure 7 shows the solid waste recovered and recycled.

Figure 7 Waste recovered by waste recovery operators in Grand-Lahou

3.2.4. Disposal of collected waste

The waste collected is dumped at the municipal landfill in Grand-Lahou which is an uncontrolled dump (Figure 8), similar to that in most inland towns of Côte d'Ivoire. Indeed, in inland towns of Côte d'Ivoire, landfills are barely developed and are not subject to methodical reconnaissance (detailed site plan, hydrology, hydrogeology, geotechnics, environmental impact study) [21]. In addition to the nuisances generated (odors, smoke, flying plastics), illegal dumps can be sources of soil and groundwater pollution [22]. In fact, these wastes produce a liquid portion known as leachate, a fraction rich in organic toxins and metallic elements. These metallic trace elements or heavy metals can be incorporated into the food chain or migrate to groundwater [23,24]. Burning waste at illegal dumps can cause air pollution (from combustion gases) and soil pollution (from ashes and residues rich in chemical components with toxic properties) [25-26]. The area chosen by the municipality as the landfill site is located near a ravine, where the waste is carried by rainwater to the Atlantic Ocean via the mouth of the Bandama river, exposing this water to the negative impact of the waste. We therefore need to build a controlled landfill site for the town to limit pollution.

Figure 8 Grand-Lahou household waste landfill with open-air waste burning

3.3. Waste composition

The mass composition of waste generated by households in Grand-Lahou is shown in table 3. This composition is dominated by the putrescible fraction with a proportion of 42.05%. This can be explained by the nutritional behavior of the inhabitants, who favor the consumption of vegetables and fruit due to their purchasing power, which corresponds to a more or less average income. The high proportion of putrescible material contained in Grand Lahou's waste suggests that organic matter can be recovered through composting. Plastics (20.25%) make up the second largest fraction of Grand-Lahou's waste. In fact, plastic bags are still widely used in the Ivorian town in general, due to their low purchase price and practical use. The state of Côte d'Ivoire issued a decree in 2013 banning the production, import, marketing, possession and use of plastic bags. Unfortunately, this measure is not respected in the field. Given the non-renewable nature of this category of waste, as well as their long life in the environment, it is imperative to set up a sorting and recovery system to limit their impact on the environment.

Table 3 Composition of solid household waste generated in Grand-Lahou

Waste components	Percent (%)
Putrescible materials	42,05
Papers	02,48
Cardboard	01,05
Composites	04,40
Textiles	03,73
Plastics	20,25
Unclassified fuels	04,10

Glass	00,53
Metals	00,65
Unclassified incombustibles	05,95
Hazardous waste	03,83
Fine elements < 20 mm	10,95
Total	100,00

4. Conclusion

This study analyzed household waste management in the town of Grand Lahou. The respondents were 35% male and 65% female, most of them over 25 years of age. Households use rubbish bags (9.5%), used buckets (30.9%), old basins (4.8%), cut cans (16.7%) and old bags (38.5%) to package their waste, which is collected mainly by the Technical Department of Grand-Lahou municipality. The waste collected is dumped at the town's municipal landfill. However, more than half of households (59%) sort a few items, such as banana and manioc peelings, used rubber shoes, buckets, used rubber containers, iron and aluminum items (used appliances and fans, tin cans, etc.), which are sent for recycling. There is a high proportion of putrescible materials (42.05%) and plastics (20.25%), which suggests that this waste can be recovered and recycled.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Statement of informed consent

All contributing authors read and approved the final manuscript for publication.

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